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NATIONAL ELECTRIC LIGHT ASSOCIATION.

Last week we took occasion to commend to our readers the work of the National Electric Light Association and the approaching convention at Cincinnati. We are now able to give fuller details this issue as to the programme, and do not hesitate to commend it as one of the most useful and practical that the society has ever had submitted for its consideration. The topics range over a wide field of practice and experience, and the names connected with them are among those foremost in the art and industry. The renewed interest thus shown in the association, and this promise of a good meeting, are most encouraging; and we believe the result will be an attendance high in calibre and large in numbers. The business of electric light and power is still young, but has already overhauled that of gas as to income; and its future depends now on better work, higher efficiencies, closer economies, finer apparatus, abler men. At the Cincinnati convention, both men and methods can be improved by the public and confidential exchange of ideas, out of which will spring a more uniform and perfected art. There will not only be plenty of work done at Cincinnati, but the local committee has outlined pleasant opportunities for recreation that will be greatly appreciated by all who attend.

THE WESTERN UNION "SHAKE-UP."

Another Lochinvar has come out of the West, and to his hands have been committed the fortunes of the great Western Union Telegraph system. Such an event as a change in the presidency of our largest telegraph company would in itself be important, but when it is associated with many changes in the management, unusual attention is called to it. Not alone has Col. Clowry assumed the leadership, but with Gen. Eckert are beginning to go the heads of various departments with which they had been equally identified by many creditable years of hard work. It was, indeed, inevitable that these changes of personnel should come; in some cases because the moment was opportune to give up duties that had grown into a burden with advancing years; in others, because a new control must, of necessity, have its own chosen agencies and means of expression. In short, the new broom is "sweeping clean," and there is a "shake-up."

So far as we are aware, Col. Clowry has general sympathy and, support from the electrical profession, because of the belief that the broad changes he is effecting are not made from a desire to enforce merely a personal policy for the sake of having one; but are due to a resolve to improve and rehabilitate the service. He has the reputation of being a forceful man; he now has the opportunity of showing himself a far-sighted, progressive one. The case might have been more hopeful with a younger president, like Mr. George Gould himself, but Col. Clowry brings with him from the West a notable snap and buoyancy. With something of the easy readiness to make betterments that goes with youth, these qualities are greatly needed in American telegraphy, which has sunk far below its proper level of efficiency and perfection. From this remark it is fair to exempt the Postal lines, but we are confident that, had the Western Union been more up to date, its rival would have gone even further, and both would be on a higher plane.

Dr. M. I. Pupin the other day complained bitterly of the antiquated telegraph methods, and said: "The Western Union does not spend ten cents a year for improvements so far as I can learn. A man who

offers them an improvement is treated like a book agent." This has been pretty near the truth. Only last week the greatest American inventor, whose telegraphic work is but part of his claim to fame, spoke to us in even stronger language of the deadness in telegraphy, and expressed the hope that a change impended. With an unprogressive art, there has inevitably been a stagnant industry, and telegraphy has stood still for years, although it ought to have been as prosperous and expansive as telephony. Much can be done to cheapen telegraphy, so that instead of sending one message a year, the average American will send ten. Automatic and machine telegraphic systems of the greatest promise, tried and approved, await liberal adoption, when a new crop of business at lower rates can be created, and telegraphy once more come again to its own. Col. Clowry has a splendid chance, and we shall be among those who are disappointed if he does not seize it at this critical juncture in his career and in the affairs of the vast property he has been called to administer and revivify.

American Enterprise Abroad.

To those who believe that successful American methods are usually correct methods intrinsically—that is, of general application and not necessarily dependent upon national conditions, material or human, as some of our foreign critics would have us believe—the recent applications of these methods abroad on a large scale must be a source of gratification. A notable example is furnished in the case of Mr. Yerkes and the London urban transportation problem. With a need for rapid transportation facilities that called for an electric railway development in advance even of most American cities and on the grandest scale, London is shockingly behind the times—indeed, has not yet reached the stage passed by most American cities ten years or more ago. Moreover, until recently the situation appeared to be hopelessly involved. Though the technical and newspaper press for years teemed with discussion on the subject, and schemes innumerable were proposed, realization at no time appeared nearer than when the subject was first broached.

Some months ago an American, Mr. Yerkes, appeared on the scene, and almost immediately the situation was cleared. The engineering problem was approached from the business standpoint, and after a thorough investigation a definite plan of development was fixed upon, which was closely followed by financial propositions which rendered the realization of the plan possible. At every stage opposition was encountered of the kind that had rendered all former endeavors nugatory, but the plans of Mr. Yerkes had the strength, both from the engineering and financial standpoint, to enable them to hold their own. Commenting upon the latest development—the consolidation of a number of railway schemes—our London contemporary, the *Electrician,* says that it really looks "as if in this magnificent project of the tireless Mr. Yerkes we have the one practicable solution of the problem of organizing a central authority to control London underground railways. As was characteristically said by that great man, Cecil Rhodes, 'there is no use of having big ideas unless you have the money to carry them out. Mr. Yerkes is not the only man who has big ideas on London traction; but Mr. Yerkes appears to differ from others in being able to find the millions necessary to carry them out." It ought have been added that the plans of Mr. Yerkes differed from the scores previously offered and academically advocated, in resting upon practical grounds that render their entire realization merely a financial question; and the needs of London and the solid nature of the investment make the matter of raising the funds a foregone conclusion. This willingness to adopt, to her own purposes and uses, men and material from outside her border is, after all, one of the real sources of England's greatness.

Modern Induction Coils.

The April number of the *Philosophical Magazine* contains a short paper by Prof. Trowbridge upon a recent development of the induction coil. The longest sparks yet obtained from any kind of induction coil are probably the high-frequency discharges of a Thomson-Tesla coil. Although these may possess enormous voltage, yet the total quantity of power usually obtained from a Thomson-Tesla coil is not very large. Of the primeval induction coils, the celebrated Apps inductorium is said to have given a 6-ft. spark; but if this was the limiting range attained, it is clear that only a small amount of power could be transformed in the apparatus. Prof. Trowbridge says he was unable to produce a spark more than seven feet long from an apparatus of the Planté type, in which condensers are discharged in series, but are charged in parallel. He believes, however, that suitably constructed induction coils may be capable of considerably exceeding this sparking distance.

The particularly noteworthy features of the coil he uses are the relatively short but powerful primary winding, consisting of a single layer of wire, and a special form of electrolytic interruptor on the Wehnelt principle. These two elements are connected in series across 110-volt mains. A small motor impresses a definite frequency upon the electrolytic interruptor. The current in the primary circuit, by ammeter, is described as varying between 5 and 10 amperes—representing, roughly, from half to one kilowatt of primary power—with a secondary sparking distance of thirty inches, at a frequency of from 5,000 to 60,000 interruptions per minute. The primary current is mentioned, however, as probably being much in excess of the indicated current at the commencement of each cycle of induction. It seems possible that by suitable design, developing the electrolytic interruptor in the primary circuit, along with high insulation in the secondary circuit, that long sparks liberating many kilowatts of power may become available for the purposes of wireless telegraphy.

The Synchronous Converter as Voltage Controller.

Inductance plays a prominent part in alternating current circuits and a particularly prominent part in the regulation of the pressure delivered by converters. In connection with these machines it has been recognized for some little time that inductance—or reactance—had a benecial influence upon the automatic regulation of compound-wound converters. Mr. Seidner's article on this subject, of which the concluding portion is printed elsewhere in this issue, contains a graphical treatment of the problem.

In the direct-current power circuit, the drop of pressure in the armature of a motor, or dynamotor at full load, is almost invariably a relatively small fraction, usually less than 5 per cent. of the pressure at motor terminals, and this is a necessity of economical transmission. In the synchronous alternating-current motor, or synchronous converter, the drop of pressure in resistance at full load is similarly a small quantity, owing to similar considerations of economy. But the synchronous impedance of such a machine is much greater than its ohmic resistance. Consequently the total drop of pressure in the impedance of the machine is a very significant quantity. At full load this impedance drop is usually an appreciable fraction of the applied terminal pressure. One effect of this large drop of pressure is to throw the counter-electromotive force of the motor or converter out of phase with the applied e. m. f., and still further out of phase with the e. m. f. at generator terminals, if the applied e. m. f. and the c. e. m. f. are nearly equal in magnitude. Another effect, however, is the possibility of adjusting the magnitude of the c. e. m. f. of the converter, and at the same time its e. m. f. on the direct-current side, by varying its excitation, within a considerable range of stable operation. In other words, if the impedance

drop in the converter were very small, there would be practically but one c. e. m. f. which could be used, and that would be nearly equal to the terminal e. m. f. This would mean a falling off in pressure between the direct-current mains supplied by the converter, as the load increased, owing to the unchecked drop in both the alternating and direct-current sides of the system. The large impedance drop, while not necessarily diminishing the efficiency, enables a considerable range of c. e. m. f. to be generated by the machine, within the range of stable operation, the phase-angles of the e. m. f. triangle adjusting themselves automatically within this range.

The ordinary method of computing the regulative behavior of the converter is by the algebra of complex quantities. Mr. Seidner develops the application of the corresponding graphical processes. It is a curious fact that the loci of the curves traced graphically by the vectors of current, e. m. f., and power-rectangles, when any of these quantities undergo simple linear variation, is frequently a conic section; *i. e.*, a hyperbola, a parabola, or a circle (particular case of the ellipse). The skill of the draughtsman who develops the converter problem graphically, is manifested in so selecting the fundamental vectors that the variable curves directly considered are simple circles, thus eliminating the more graphically troublesome parabolas and hyperbolas. There can be no doubt that by plotting the various magnitudes vectorially, on a fairly large scale, the effect of load variations and their action on a compound-wound converter can be revealed to the eye with an accuracy that is sufficient for practical purposes. On the other hand, however, although the graphical method is swift and convenient, it requires to be checked occasionally by the algebraic method for confirmation, and whoever possesses the insight into the phenomena sufficient to draw the geometrical figures, should have no difficulty in making such corresponding numerical computations.

There are consequently two different kinds of alternating-current circuits in which the presence of judiciously inserted reactance may be beneficial. One of these is the automatically regulating compound-wound converter, above considered. The other is the case of a long-distance telephone circuit, in which additional artificially distributed reactance increases the strength of the received current. The modes of action of the extra reactance in the two cases are, however, quite distinct.

THE GROWTH OF ENGINEERING EDUCATION.

It is a profoundly interesting thing to look back over the past twenty years and to contemplate the change that has taken place in the facilities for technical education, and what is of vastly more significance, in the public attitude toward professional training. The attitude of educators in the early eighties toward the modern education was for the most part a mixture of distrust and dislike. In a measure the persistent labors of leaders like Eliot, of Harvard, and Gilman, of John Hopkins, had brought the thinking public to a realization that Latin, Greek, and mathematics did not constitute the sum total of human knowledge, and that laboratories had their uses; nevertheless the general trend of the scholastic mind was against the innovations. It was right and proper that a clergyman, a lawyer or a physician should receive a full and adequate professional training, but the engineer should learn by hard knocks, in the field, in the workshop—anywhere and anyhow—provided he did not ask for resources that had been devoted since time immemorial to the digging of Greek roots. Far be it from us to cast aspersions on the classical education. It is in itself a good thing, worthy to be pursued as a preliminary to his professional education by anyone who can spare the time and money. But the attitude of quiet contempt taken by the old-timers toward any proposal looking toward a first-class scientific education was unmistakable. The chairs of science in the colleges and universities were then in great measure filled by men who had graduated in the sixties, had taught in high schools for a year or two, or perhaps attended a theological seminary and had then come back to the Alma Mater as instructors in classics or mathematics. A few years later a chair in science became vacant through the death of the venerable incumbent, and the instructor had pull enough with the trustees to drop comfortably into it.

Some of the men thus ensconced were big of brain and keen of perception, and grew with the growth of their science—others gradually fossilized. But to all alike, the requirements of the new education came with something of a shock. The old education could make scholars with a man, a book, and an unused barn—the new demanded apparatus and laboratories, workshops and machinery. Funds were short and the trustees quailed. To spend on a single piece of apparatus a sum sufficient to buy a complete set of the Greek and Latin Fathers was a bitter thing to contemplate. Fortunately, engineering science grew and prospered materially, and men came to the front—hard-headed business men who had touched the sources of American prospecrity and looked into the future. They reached into their pockets and began to endow. Money that if given at all ten years before would have gone to found a professorship of Aztec literature went to build an engineering laboratory. Within a decade the change was wrought, and without casting out the old the new had come. It came, too, with a rush that bore along even the most hide-bound institutions, until to-day there is hardly a college in the land where a student cannot get a solid grounding in science from well trained and progressive men. The technical schools have grown at a rate even more astonishing, and to-day if a young man wants a good technical training it is his own fault if he does not obtain it. The scientific school is clear of the ancient odium. Its graduates are neither looked down upon by the scholastic nor condemned by the practician. In fact, it is generally recognized that a man without technical training has a very hard row to hoe in modern engineering. It is a wonderful change, not only in material things but in point of view, and it is hard to overestimate its importance both to general educaton and to practical affairs.

There are some who pretend to despise education, technical or otherwise, for men of affairs and action, but their names shall be writ in water, while above the strand will loom the great figures of Carnegie and Rockefeller with their huge benefactions in the cause of education, and of Cecil Rhodes, struggling back to Oxford for his degree, laying the foundations of an empire, and leaving his fortune for training others to play well their parts in the world's work. The place which America has taken of late in the industrial sphere we believe is due in no small measure to the increasing number of men skilled in the engineering arts, the direct product of the new education, and this influence will year by year grow stronger. As times goes on we must look to it that the trend of education keeps on the line of progress. There will be no return to mediævalism; the danger, if there is any, lies in another direction—that the power of utilization will overrun that which reflects and originates. It was a keen appreciation of this that brought the Carnegie Instutition into being—a far-sighted realization that the theory of to-day is the practice of to-morrow, and that a big structure requires broad and deep foundations. If this country is to keep in the van it must find and take advantage of every short cut in sight that leads toward the goal. Otherwise there is waste of energy, a thing which the spirit of progress abhors. The growth of education must keep pace with the demands of the times, and when as now the opening century demands great things, it is no time to be self-complacent. Just now pure science is in a questioning tentative state, that state of unrest which preceds momentous advances, and the keener eyes are watching for the results. Practice can care for itself amply well for a while, and it is time to have a care lest we get out of sight of theory and miss the shortest trail.

Programme of the National Electric Light Convention.

Plans are now well advanced for the convention of the National Electric Light Association, at Cincinnati, May 20—22, at the Grand Hotel, and every indication promises a most interesting and successful meeting. It is the twenty-fifth convention, and President Doherty has resolved that it shall be a worthy starting point for the next period in the association's history. Secretary Porter has forwarded us the following preliminary programme:

"Rates," Henry L. Doherty, Denver; L. A. Ferguson, Chicago, Alex. Dow, Detroit; L. R. Wallis, Woburn, Mass.; Ralph J. Patterson, Waterville, Me.; Samuel Scovil, Cleveland, O.

"Signs and Decorative Lighting." Papers by Russell Spaulding, of New York, and E. J. McAllister, of Newark, N. J.

"Are Free Lamp Renewals Desirable?" James English, New Haven, Conn.; F. Ellwood Smith, Somerville, Mass.; F. W. Little, Peoria, Ill.; W. J. Greene, Cedar Rapids, Ia.

"What Efficiency Lamp Should be Used?" Henry L. Doherty; Samuel E. Doane, Marlborough, Mass.; L .G. Van Ness, Denver; Francis W. Willcox, Harrison, N. J.

"What Improvement is Desired in Meters?" Robert Ferris, Monmouth, Ill.; C. A. White, Somerville, Mass.; H. H. Scott, Lincoln, Neb.

"Are Loose-Leaf Ledgers Desirable for Electric Companies' Records?" G. E. Tripp, Boston; H. H. Fairbanks, Worcester, Mass.; Geo. W. Davenport, Boston; Charles R. Price, New Bedford, Mass.

"The Advantages of Gas Engines." Chas. H. Williams, Madison, Wis.

"What Changes Should Be Made in the Plan of Uniform Accounting?" J. P. Crowley, St. Paul, Minn.

"Caring for Consumers' Complaints." Irvin Butterworth, Denver.

"Boiler Firing with Oil." Jas. W. Warren, Los Angeles, Calif.; H. T. Edgar, El Paso, Tex.

"Three-Phase vs. Two-Phase for City Distribution." B. A. Behrend, Cincinnati; Chas. F. Scott, Pittsburg.

"Hot Water vs. Steam Heating." J. F. Porter, Alton, Ill.; P. H. Korst, Jamesville, Wis.; C. R. Maunsell, Topeka, Kan.

"Does It Pay to Treat Poles with Creosote, Oil or Other Compounds?" W. E. Moore, Augusta, Ga.

"Gas Explosions in Underground Systems." James Blake Cahoon, New York.

"Protection of Long-Distance Transmission Lines." F. C. A. Perrine, Pittsfield, Mass.; L. Denis, Quebec; P. N. Nunn, Provo, Utah; P. M. Lincoln, Niagara Falls, N. Y.; H. J. Gille, St. Paul.

"Present Performance of the 220-Volt Lamp." Fred. W. C. Bailey, Columbus, O.

"Report of Committee on Photometric Values of Arc Lamps." Henry L. Doherty, chairman.

There is also the "Question Box," which this year is literally buzzing with importunate queries of a most interrogative character.

Steps have been taken to provide entertainment, and the following gentlemen form the local reception and entertainment committee: H. C. Hutchison, chairman; Norman C. Kenan, A. C. Beattie, B. T. Price, J. B. Pevear, O. M. Hall, Thos. Ryan, Samuel Moyer, Samuel W. Glover, Alexander Lewis, H. J. Douds, John A. Devere, J. W. Bullock, Jesse Bindley, Edward Gillette, Wm. S. McCallum, C. B. Humphreys, Frank Lawrence, F. C. Colwell, Frank G. Bolles. This committee has arranged, among other entertainments, visits for the ladies to Rookwood Pottery and Cincinnati Museum of Fine Arts; a trolley ride through the city and suburbs to the Zoölogical Gardens, where luncheon will be served. The Bullock Electric Manufacturing Company has arranged for a trip to and through their works.

The Grand Hotel is headquarters, with rates of $3 per day, on the American plan, and $1 per day, and upward, on the European plan. Details as to transportation have already been published.

Electrical Engineers of the Day—XLV.

JOHN W. HOWELL.

John White Howell was born in New Brunswick, N. J., and received his education there and in New York and Hoboken, taking six years of college work—one at the College of the City of New York, two at Rutgers, and three at Stevens Institute of Technology with the class of 1881. Mr. Howell took no degree at any of these institutions, but in 1899 was given the honorary degree of Electrical Engineer by Stevens Institute. Mr. Howell's thesis at Stevens was the means of starting him in his career. The Edison incandescent lamp had recently been invented, and Mr. Howell made his thesis on the subject, "Economy of Electric Lighting by Incandescence." This was one of the earliest contributions to the theory of the incandescent lamp, and attracted so much attention that it was reprinted in book form.

As a dircet consequence of this thesis, Mr. Howell was soon after (1881) employed by the Edison Lamp Company, then at Menlo Park, N. J., on technical and experimental work, and has been employed in the Edison Lamp Works ever since. Mr. Howell developed the first successful electrical pressure indicator used on electric lighting circuits and also the system of indicating pressures at various feeder ends, which was generally used for some years. This system of indication made it possible to maintain the voltage at the lamps sufficiently close to operate high efficiency lamps with acceptable commercial life, and paved the way for experiments in burning lamps at 3.1 watts per candle-power, which were made by Mr. Howell and his brother, on the circuits of the Edison Electric Illuminating Company, of New Brunswick, and resulted in the adoption of lamps of that efficiency by lighting companies having good voltage regulations.

In the litigation over the Edison filament patent, it was Mr. Howell, who, after all others than Mr. Edison had failed, succeeded in making lamps as described in the patent specification, an achievement interesting on account of the primitive methods necessary to be observed in their manufacture. Tar and lampblack were rolled into filaments by hand as small as six-thousandths of an inch in diameter

and twelve inches long. The only tools used in making these filaments were a piece of plate glass, a stick, a garter clip, a pen-holder, some carbon rods, wire and a crucible. These lamps were burned on a life test six hundred hours, and justified the claims of the patent.

Hr. Howell has acted as an expert in most of the suits brought under the various Edison patents on lamps. In the litigation over the Novak lamp, Mr. Howell determined the amount of bromine in the lamp by a purely electrical method, his determination being afterward verified by the makers of the lamp. He has contributed numerous papers to electrical literature, several of which were read before the American Institute of Electrical Engineers, of which body and of the American Association for the Advancement of Science, he is a member. When the General Electric Company was organized, Mr. Howell was made engineer of the lamp works, which position he still holds.

Mr. Howell's patents and applications now pending on lamp and allied subjects are thirty in number. He has been largely instrumental in developing the art of lamp manufacture to its present degree of perfection, and in everything relating to the theory and practice of the art is recognized as the leading authority, both at home and abroad.

Mr. Howell has profited greatly by personal contact with Mr. Edison. In the early days of the incandescent lamp industry he received a deep insight into the master's conceptions of the art, which, together with Mr. Howell's natural ability, high character and fitness for the work, has placed him at the head of the world's lamp makers.

The Electric Elevated and Underground Road of Berlin.

A PLAN of Berlin clearly shows that a line of traffic running from east to west is sadly needed in the southern section of the city, in order to complete the belt line which was started many years ago. It was 20 years ago when Werner von Siemens first conceived the idea to supply Berlin with electric elevated and underground railways. One of these lines was planned to pass through the Friedrichstrasse, while another was to run through the Leipzigerstrasse. These suggestions were laid aside for various reasons, and it was not until 1891 that Siemens & Halske worked out a complete plan for an elevated road which would join the Warschauer Brücke railroad station with the Zoological Gardens. The traffic at that time already demanded the construction of such a road, which has now been completed with but a few slight alterations. The line now takes an east-westerly course with a branch to the north.

One of the most interesting features of the road is the connecting triangle, which lies to the east of the Potsdam freight depot. At this point three lines pass over and under each other, so there are no crossings at the same level. This removes three danger points and makes greater headway between trains possible, which is very desirable, as three lines of trains pass at this point.

At two points along the road the elevated and underground sections join, the grade at these junctions being 31.3 per cent. Fig. 1 shows a section of the subway and also the third-rail. The latter is situated outside of the two rails and 230 mm above them. On the elevated structure the third-rail is located between the other two rails and 180 mm above them. The reason for this difference of height is the necessity for the automatic shoe contact for the lighting of the cars in the subway.

The following circuits compose the system: 1. Operation of the trains. 2. Lighting of depots, signal houses, car-houses and workshops. 3. Signal apparatus. 4. Telephones. 5. Electrical operation of signals and switches at the triangle. The circuits for the operation of cars are located 1,096 mm from the center of the track. They consist of rails 3,600 sq. mm in section, and 12 meters in length. These rails also carry current for lighting and heating the cars. The rails are 180 mm above the rails on the elevated section, and 230 mm above in the subway.

The bare copper feeders are rectangular in shape and have an

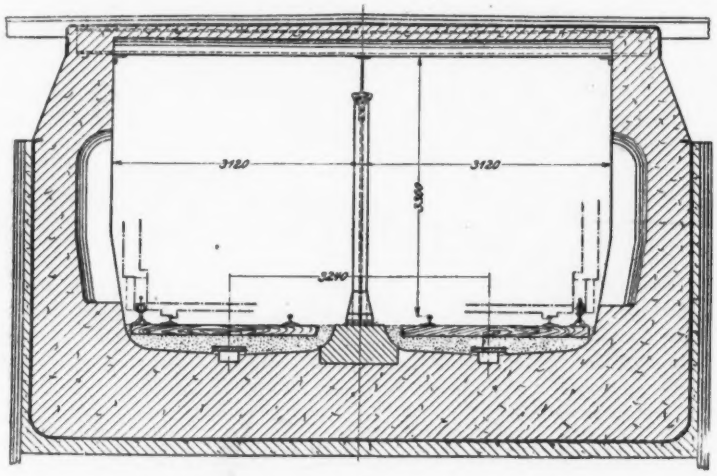


FIG. 1.—CROSS-SECTION OF UNDERGROUND ROAD.

area of from 1,000 to 1,500 sq. mm. The lighting wires for stations are also bare, and are situated next to the feeders.

As shown in Fig. 1, two longitudinal wooden beams are bolted to the transverse beams, 6 meters apart. These carry cast-iron brackets, within the hollow space of which the feeders and lighting wires are supported on insulators. The latter are fastened to a piece of flat iron, while the third-rail insulators are fastened directly to the wooden beams. To the top of the brackets guard beams are fastened, about 130 mm above the third-rail, which prevents anyone from stepping on the latter. Where telephone wires cross the elevated structure, 8 mm wires are fastened to the guard rail, and are connected to the return circuit, being, therefore, grounded, which gives ample protection to telephone apparatus in case a wire should break. All distances between track centers, etc., are altered at curves.

A somewhat different construction has been adopted at the Bülowstrasse Viaduct. The brackets are mounted on longitudinal sleepers, and the third-rail on transverse beams. At terminal stations and switches, the third-rail is not continuous, but the trains continually receive current, because the trains are provided with four contact shoes at each side, there being two on each side of each motor car, so that in case the front shoes should slide off the rear ones still collect the current. The several sections of the third-rail are connected together by means of cable.

In the car-houses the conducting rail is located to one side and

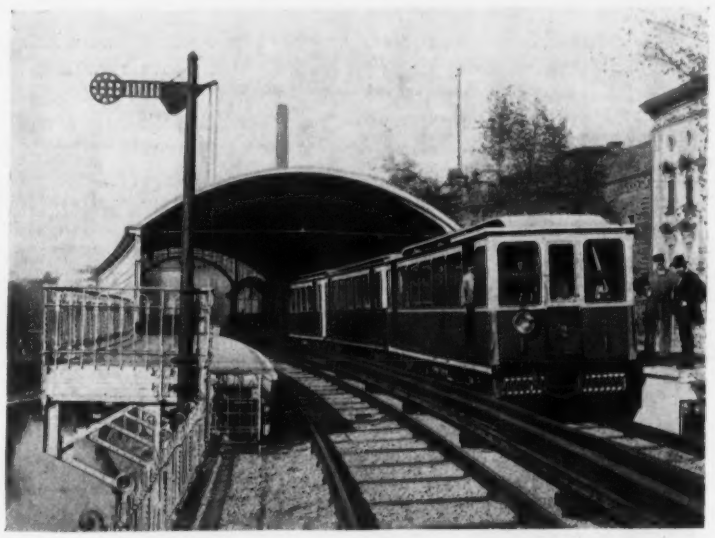


FIG. 2.—ONE OF THE OVERHEAD STATIONS.

above the tracks. It consists of an angle iron, which is covered by a ⌐¬ shaped wooden board, so as to protect it.

As indicated in Fig. 1, the contact rail in the tunnel is not located between the tracks but to one side of each set. It is only protected at the tunnel wall recesses. The rail is laid higher than on the elevated section so that automatic contact is made for lighting the car when the train passes from the overhead to the subway section. The insulators are attached to the extended sleepers, which are situated 6 in. apart.

The lighting wires are of such section that at the Warschauer Brücke depot, when the lamps at all depots are burning, there is a pressure of 660 volts, the pressure at the power station being 750 volts. At the intermediate depots the pressure is reduced to 660 volts by means of rheostats. This pressure is suitable for 12 arc lamps connected in series, each taking 55 volts, or three incandescent lamps, in series, each taking 220 volts. The cross-section of the lighting wires varies between 10 and 120 sq. mm. When some depot lamps are cut out, the pressure naturally tends to rise, but it is kept constant by a regulator which is operated at the central station by means of test wires. At several points the lighting wires are connected to the power circuits, so that the latter can be used for lighting purposes in case of accident to the former. These cross-connecting cables are 1,089 mm in diameter. The rails, used for returns, are connected together at the joints by copper bonds, and crosswise by copper rods.

Cables are used for signal and telephone purposes, and the current is returned through separate return circuits. Each depot is connected to the two adjoining ones by telephone, and may be connected in this way with any other depot at the central station. The number of wires in the telephone cables differs, therefore, at each depot, the number varying between 6 and 22, and the diameter of the cable between 20 and 28 mm. Cables are also used for carrying current to the signaling and switching apparatus at the junction triangle. These cables are also attached to the guard beams.

The insulators carrying the third-rail are covered by cast-iron caps, which are screwed to the central hard rubber portions. There is one insulator for each rail length, and a flange grasps the foot of the rail so as to prevent the latter from moving. Double insulators are used for feeders, the outer portion being of porcelain and the inner of hard rubber.

Each train consists of two motor cars with a trailer between them

The motor cars are provided with only one operator's platform, and the cars are so arranged that these platforms come on the two ends of the train.

The motors on each car are always connected in parallel. When the train starts in the forward direction the two sets of motors in the two cars are connected in series through a resistance. When going backward the motors in the leading car only are brought into action. The same for braking when one set of motors is cut out. The trucks and couplers of the motor cars and trailers are alike, the cars only differing in their interior arrangement. The two ends of the trailer are the same and do not differ from the ends of the motor cars, which they adjoin. The motor cars constitute the third-class and the trailers the second-class.

The exterior length of the car body is 12,000 mm. The width is 2,260 mm between sides of body. The height above rails is 3,180 mm. The wheel base is 1,800 mm. Distance between king-pins 7,500 mm. Weight of empty motor car 18,000 kg. Weight of loaded motor car 22,000 kg. Weight of empty trailer 13,000 kg. Weight of loaded trailer 17,000 kg.

The car bodies rest on a channel-iron beam frame, and are constructed entirely of wood. There are two slide doors 900 mm in width on each side at each end of every car, which lead to a sort of anteroom and not the actual car interior. One set of doors is intended for entering and the set at the other end for alighting passengers. There is, furthermore, an emergency door at each end of each car which connects with the adjoining car. This door is 1,700 mm in height and 520 mm wide, and can be closed by means of a bolt lock. Each

FIG. 3.—VIEW OF INTERIOR OF CAR SHOP.

trailer has 44 seats and each motor car 39 seats. They have standing room for an additional 30 and 27 persons, respectively.

The single buffer couplers are provided with evolute springs, which take up the pulling as well as pushing strains. The diameter of the buffer plates is 280 mm.

For ventilation 12 windows, 140 mm high and 700 mm long, are located at each side beneath the roof of the car. They can be so turned that the fresh air may enter through the front windows and the foul air escape through the rear ones.

The cars are heated by means of electric heaters placed beneath the seats and covered by a casing so that they cannot be touched. To prevent clothing of passengers from being overheated or burned, rods are fastened in front of this casing. Each car is lighted by 12 incandescent lamps. At the front and rear ends of the train two signal lamps are fastened. The lamps in the cars are fed by two circuits, so that in case one circuit is interrupted the car will not be in darkness. In addition, candles may be lighted in case of necessity. The contact shoes are attached to the sides of each motor car and trailer, so that at crossings the current is not interrupted.

A 30-mm wall divides the motorman's compartment from the rest of the car. In this compartment are the switches, switchboard, air-brake valves and manometer. A bell serves for giving ordinary signals, and a whistle for danger signals. The steel rims are sprung around the wrought-iron wheels of the trucks. The running surfaces are cylindrical, and the diameter of the wheels 850 mm.

Each truck is equipped with a four-shoe brake, which is operated by means of air pressure, or by hand from the motor car. The forward motor car of each train may be braked by the short-circuiting of its motors. The hand-brakes, which are only used when a single car is operated, are of the ordinary street-car type. The air brake is of the two-chamber Carpenter type. The braking cylinder, the air chambers and pipes as well as the pump are located beneath the car body. The pump is operated by an electric motor, the two machines being housed in one casing.

A part of the braking rods is attached to the frame and a part to the truck, which is provided with special iron fittings for catching the broken rods in case of accident. The braking apparatus has been so designed that the maximum braking pressure is 70 per cent. of the moving load, *i. e.*, 12.6 tons on the motor car and 9.1 on the trailer.

Each motor car is equipped with four direct-current motors in such a way that each axle is driven by one motor. The motors are the four-pole type and are of such capacity that the train can attain a maximum speed of 50 km per hour. The greater part of the weight of the motor is carried by a piece of flat iron fastened to the truck by means of springs, and a small part of the weight by the axle to which it is connected by means of clamps.

In case only one trailer is used on a train, each motor car is equipped with only three motors, and only when two trailers are used are four motors necessary. In the case of four motors, when running at full speed, all eight motors of the train are connected in parallel. Each controller contains two cylinders, one for the motor and one for the resistance. The former consists of two halves, each having its row of contact points. The resistance cylinder has a top and bottom contact for making connection with the resistances and a row of contact points making connection with the motor cylinders. The contact wheel can only be removed when the motor cylinder stands at zero, and in this position the motors are in circuit. In case the motor cylinder of the rear car is left at the zero point, which is necessary for taking off the hand-wheel, these motors are in a position to receive current when the same is sent through the cable joining the rear and forward motors. But if the motor cylinder of the forward car is also at zero, then the finger of the other car receives no current. In order to start, the current first enters at one contact finger, passes through the contact point of the motor cylinder to another contact finger, and from there to the spark-extinguishing coil to the first contact finger of the resistance cylinder, through the top and bottom contacts to the resistances which are connected in series; then through the motors of the first car, through its contact finger, through the junction box into the connecting cable to another contact finger on the rear car, through the zero contact point to another contact finger, through all the motors of the second car, and finally to earth. As the resistance cylinder is revolved, resistance is gradually cut out and the motors are connected in parallel in the well-known manner. In this way it is possible to control all motors from the forward platform, using only two connecting cables.

In tests of a train over an average distance of 800 m, between stations over a level section, the moving weight was 64 tons, the acceleration .695 m per second, and the maximum speed 11 m per second, which corresponds to an average speed of 30 km per hour. The retardation caused by braking is 1 m per second. The maximum speed may be increased to 12 m per second, which enables the train to make up for any loss of time. The transmisison ratio is 1 :4.14 and the consumption 38.6 watts per ton-km.

The generating units are located in the basement, above which is the pipe gallery, and above this the boilers. The water is received from the Landwehr Canal.

There are a 15 and a 20-ton electric crane in the engine room. The chimney is 80 m in height, only 65 m of which is used, because the boilers are located in the top story. There are six water-tube boilers, working at a pressure of 10 atm, and each having a heating surface of 230 sq. m. Superheaters raise the steam temperature to 225 degrees C. By means of valves the superheaters may be filled with water and used for the generation of steam. Two steam pumps, each of 40-cu. m per hour capacity, feed the boilers. The steam pipes are arranged in ring fashion, and are of the Mannesman make. The joints are of cast-iron with wrought-iron flanges.

There are three internal pole, separately excited, Siemens & Halske generators, each of 800-kw capacity at 750 volts. The con-

nections of the machines are shown in the drawing. The current is led to the switchboard by iron-armored lead-covered cables. These are connected to the ordinary automatic circuit breakers and fuses. There is a separate switchboard for the boosters and the lighting and charging batteries, and this board is connected to the main board by cables.

The battery is capable of replacing one entire unit for one hour and furnish considerable more current for a shorter time. The battery is located under the three arches of the elevated railway viaduct.

The engines are coupled directly to the generators. They are compound condensing engines, having a 750-mm stroke and 800 and 1,270-mm cylinder diameters, and the engines have a normal capacity of 900 and maximum of 1,200 hp at 115 r. p. m., and a pressure of 9 atm. The high pressure cylinders are equipped with new Collman valve gear, while the low pressure cylinders are equipped with piston valves. The fly-wheels weigh 33,000 kg. Next to each fly-wheel is the starting device, which is operated by a 20-hp electric motor, which is common to all units. This device is cut out as soon as the speed of the engine exceeds that of the motor.

Air pumps and condensers are located in the basement, and are driven directly by their corresponding engines. The water pipe leading to the condenser is 750 mm in diameter, and connects two reservoirs in the basement with the canal. The water of condensation first flows into a well through a 800-mm pipe, and then into the Landwehr Canal.

The Electrical Equipment of the Experimental Model Basin at Washington Navy Yard.

BY J. ADGER MCCRARY.

SOON after the completion of the electrical equipment of the experimental model basin at the U. S. Navy Yard, Washington, D. C., there appeared in several of the leading magazines of the country an article describing the plant, but no effort was made to describe fully its electrical features. In this article it is proposed to give a more detailed description of the machinery and apparatus employed, and to deal more particularly with the electrical devices used.

The experimental model basin, which is 40 feet wide by 470 feet long, was built for the purpose of finding for different shaped and different sized models of vessels the actual resistance to be overcome for all speeds corresponding to those the vessel is likely to go, and from the results of these experiments the actual performance of a proposed design may be closely approximated.

Now, in order to do this it is essential that the model be towed through the water at the displacement corresponding to that of the vessel it is made to represent, and at a uniform speed; for unless the speed of towing be uniform or very nearly so the measurement of the resistance would be next to impossible. For the purpose of giving the models a uniform speed, a towing carriage spanning the basin and running on tracks on each side and driven by four electric motors is employed. The carriage has considerable weight (about 25 tons), hence it acts as a fly-wheel to an engine, viz., when it is once started and up to speed small variations of resistance such as is offered by the model being towed and any irregularities in the track have very little effect upon its speed.

The driving motors are coupled in pairs through gearing by a rigid shaft across the carriage. They were made by the General Electric Company, and are wound for slow speed and excessive overloads. For the control of the speed of these motors the Ward Leonard system is used, the principle of which is to vary the e. m. f. applied to the armature circuit, while the fields remain constantly excited from a separate source. To accomplish this is installed a generating plant consisting of three 125-kw General Electric generators—220 volts at 250 r. p. m.—direct-connected to McIntosh Seymour engines; and two General Electric marine-type generating sets—110 volts at 400 r. p. m.—of 15-kw and 40-kw capacity, respectively. The switchboard is so arranged that any one of the 125-kw generators may be run self-exciting at 220 volts, in this case to supply power to the construction shops of this department; or all three may be coupled in parallel for the same purpose when more power is needed; also, any pair may be coupled in series when it is desired to run the carriage at very high speeds.

The 15 kw and 40 kw generating sets are used for exciting the fields of the motors on the towing carriage and the fields of the 125-kw generators. The switchboard is so arranged that either one may do this work, keeping the other in reserve, or for other work.

FIG. 1.—TOWING CARRIAGE AND MODEL BASIN.

When running ordinarily only one of the 125-kw machines with one exciter is used, and from these machines to the experimental model basin building for transmission of power are three lines of cable. The one for the main armature circuit for the motors is carried to trolleys on each side of the basin. These trolleys con-

sist of 44-lb. rails bonded together at the ends and placed just above the tracks upon which the carriage runs, and contact is made with them by means of three large cast-iron shoes which are pressed up against and slide along the rails. The steel springs causing the pressure are not depended on for carrying the current, flexible copper strips being used for that purpose. The other two lines from the station go to trolleys of ordinary Figure 8 section copper, and contact is made by means of ordinary trolley wheels. One of these lines is used to transmit the 110-volt exciting current for the motor fields, while the other is used to connect the fields of the generator through rheostats to the 110-volt exciting source. There are two of these rheostats placed in easy reach of an operator on the carriage, and each has about 140 ohms resistance. One has five binding posts and is connected up to an ordinary reversible car controller with five notches in either direction and an off notch, while the other has 46 buttons and is connected in series with the first; thus, by the use of the two almost any resistance within the range of the rheostats can be obtained, and the voltage of the generator may be changed through a range from 0 to about 250 volts, according to the amount of resistance inserted—this voltage, of course, being reversed by a reversal of the controller handle. This reversal of e. m. f. applied to the armatures of the motor with separately excited fields gives rotation in either direction desired, and hence a travel of the towing carriage in either direction is obtained at will.

The towing carriage being very heavy it is necessary to give it a very great acceleration at starting when high speeds are to be obtained, in order to have the speed thereafter uniform. To get this acceleration the 125-kw generators are compounded, and the large current necessary for starting is made to go around the fields and help to bring up the voltage just when it is most needed, and while the current of the shunt fields has not yet had time to reach its full value. This series current, which is at first very large, gradually falls off as the carriage increases in speed, and the shunt fields which have now had time to reach their full value keep the e. m. f. practically constant and the carriage moves at a fairly uniform speed. To bring the carriage to rest when once under way it is only necessary to bring the controller handle to the off notch, provided the speed is not too great for the friction of all wheels, gearing, etc.; combined with the generator action of the motors this tends to bring the carriage to rest, but when the speed is greater it is found necessary not only to bring the controller to the off notch but immediately to reverse it and at once cause the generators to tend to drive the motors in the opposite direction. Of course, if the controller were then left in this position the carriage would immediately start in the opposite direction; this is avoided by putting the controller handle on the off notch just when rest is obtained. It will be seen then that by means of this controller a skilled operator can move the carriage in either direction at will with ease and exactness.

For speeds varying from one-half knot per hour to about 7 knots per hour, the four motors are connected in series, but for higher speeds arrangement is made on the switchboard (Fig. 2) for connecting the four in series parallel; with this combination a speed of 18 knots per hour can be obtained, and even at this speed the generator action of the motors is used to bring the carriage to rest, although it has been found necessary to plug the circuit breakers both in the station and on the carriage, for the current is much greater than that for which the breakers are designed. This excessive current on stopping makes quite a flash at the commutator of the generator, but as it lasts only a short time (only about 3 seconds at most) it does very little damage. In fact, it has not been necessary to true the commutator on account of it, and one generator has been in almost constant use for three years.

On the carriage is seen (Fig. 1) two hoisting cranes for handling models about the building; these are operated by two 110-volt shunt motors fitted to winches, and have reversible controllers. For raising and lowering the central portion of the carriage is another small motor, and again hidden inside the desk (Fig. 2) is a 1-hp, 110-volt motor which operates the dynamometer. This is accomplished by means of two magnetic clutches, one on each end of the motor shaft, and by means of a multiple switch, either one of these clutches may be made to engage and put more or less tension on the dynamometer spring as desired, the motor always running in the same direction. The recording drum (Fig. 2), upon which a sheet of paper is fastened, and upon which time, distance and resistance

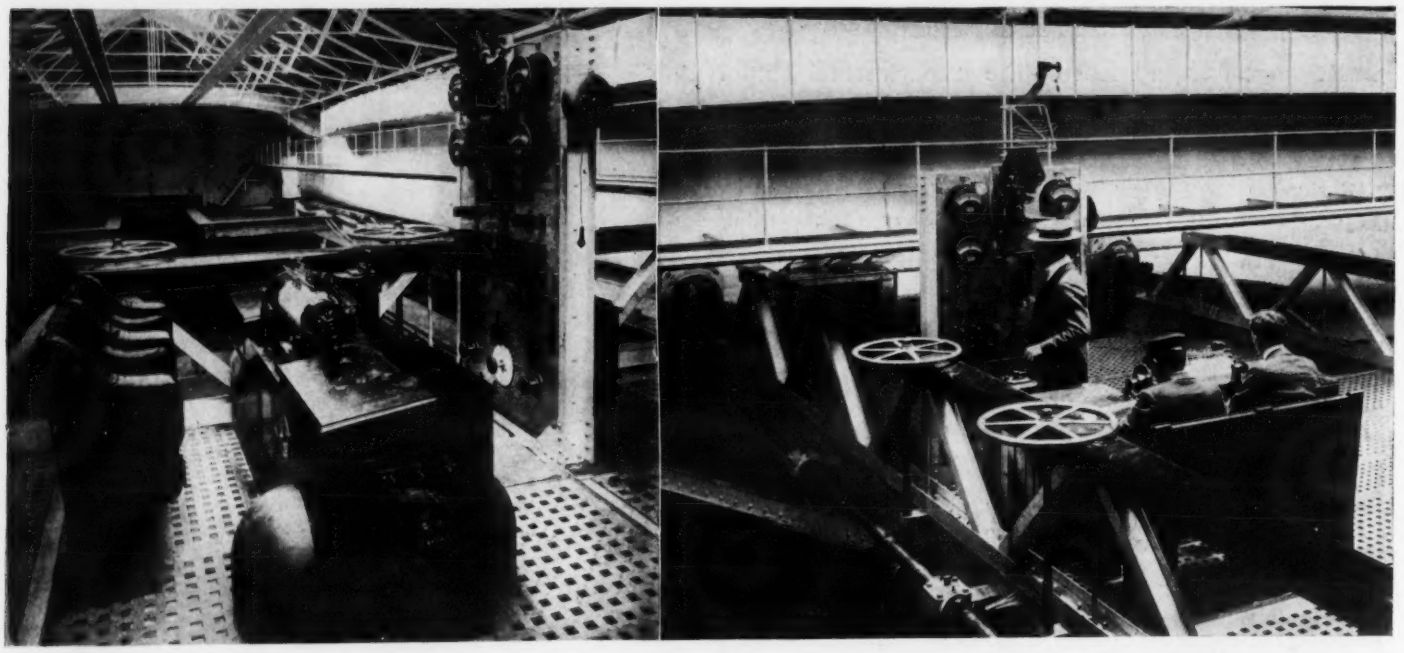


FIG. 2.—SWITCHBOARD, RECORDING APPARATUS, ETC., ON TOWING CARRIAGE.

are recorded, is also thrown into action by a magnetic clutch. These magnetic clutches are in reality friction clutches, for the power transmitted depends upon the friction between the magnet and its armature. They have three collector rings and are wound with two separate coils, one of the coils being only a few turns, through which a small current flows continuously in opposition to the magnetizing current. This demagnetizing current, with the help of small springs and a copper sheet between the magnet and its armature, causes the clutch to release almost instantly. The recording drum is connected through gearing to one of the cross shafts of the carriage, and the time record is made upon it by means of small pencils actuated by electromagnets, in the circuit of which is a break-circuit chromometer. The distance record is made by similar pencils, but in this case the circuit is broken as the carriage passes by small pegs located at definite intervals along the track. For these small time and distance magnets storage batteries are used as source of current.

It might be mentioned that in the model basin building there are several other motors. One 2½-hp, 110-volt is connected to a plunger pump which furnishes pressure for a hydraulic friction brake used to bring the carriage to rest when the electrical braking action is not brought about soon enough to accomplish its purpose. One 35-hp, 220-volt motor drives a large fan for forced heating and ventilation. For pumping the water out of the basin there are

three others, all 220 volts; the largest, 25-hp, is dircet-connected to a centrifugal pump, and its speed is controlled by the Ward Leonard system.

In connection with the model basin is a shop for the construction of models to be tested (Fig. 3), and here each machine is coupled to its individual motor, in some cases by belts, in others direct to

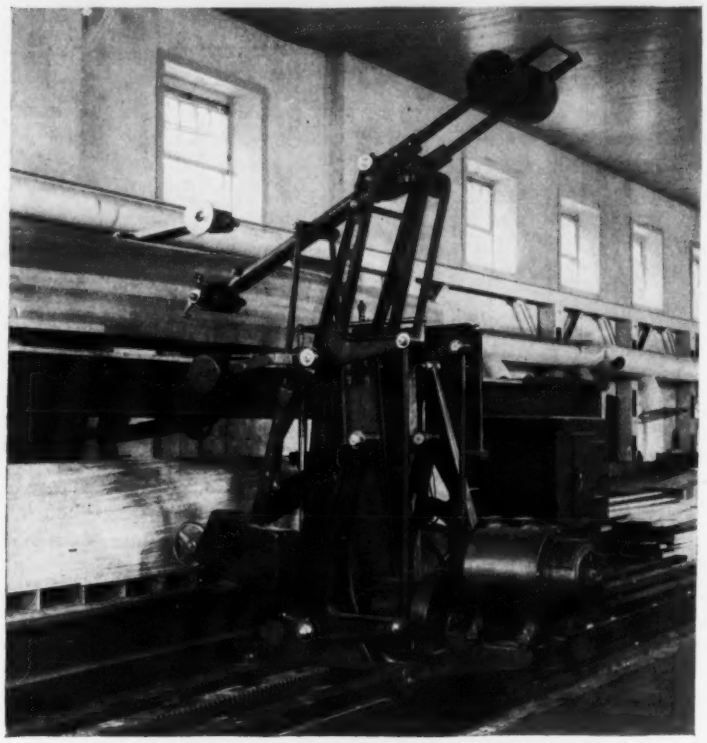


FIG 3.—MODEL CUTTING MACHINE.

the machine. The power is delivered to the motors through a cable line under the floor near the center line of the building, from which branch lines lead off on each side to switches and starting boxes located on the wall. The switch, fuse-block and starting box for each motor is mounted on a neat wooden board which stands out from the wall, and the wires are brought up from behind through the board to their proper binding posts.

Message Rates in Independent Exchanges.

The Maryland Telephone and Telegraph Company, operating an extensive independent system in Baltimore, has found that flat rates for telephone service in a large city do not give satisfactory results. The company has introduced in the city council of Baltimore a bill to release the company from the provision of its franchise, which prohibits it from charging more than $48 a year for business service and $36 a year for residence service. In supporting this measure before a meeting of the council on April 28th, President Bouton, of the Maryland Telephone Company, said that experience had shown that the operating expenses per telephone increase with the number of telephones in use, by reason of the increased average use of the service by each station with the growth of the system. He stated that the operating expenses per subscriber in Baltimore were more than twice as much as the operating expenses per subscriber in the company's exchanges in smaller towns. His company furnishes many subscribers in Baltimore with service at a loss, as there are many large users paying a flat rate of $48 a year who send on an average as many as 15,000 calls in a year. Mr. Bouton pointed out very fully the limitations and disadvantages of the flat rate, and agreed that if the city council would withdraw the present restriction on the company's rates, he would institute a message rate schedule which would give low rates to the small users, and enable the company to charge all users a rate in proportion to the amount of service rendered.

This is the first instance, it is said, of an independent telephone company acknowledging the incorrectness of the flat rate principle and planning to adopt the message rate system, which for some years past has been so actively developed by the Bell Telephone companies as a result of their experience.

The Genesis of Wireless Telegraphy.

BY A. FREDERICK COLLINS.

SINCE wireless telegraphy has assumed a position in the front ranks of electrical arts and pursuits, the issue of priority of discovery and invention has developed a condition of affairs second only in its importance to the proposed measures which are to exterminate the menacing monopoly of it on the high seas.

The progress of all great things is necessarily slow, and a useful invention of any magnitude is not the accomplishment of one man but the combined result of the efforts of many minds.

Even the discovery of the Röntgen ray, so marked in its nature and wonderful in its operation, does not in its personified term offer an inkling of the laborious experimenting of Geissler, Crookes and the many other lesser known investigators who made the brilliant discovery a mere bagatelle for him who was destined to observe it.

A history of how each great invention and discovery has found its affinity in the name of a single worker, to the exclusion of all others, living or dead, would make interesting reading and doubly so if the narrative would give the Alpha and the Omega of the art with the names of everyone who helped to consummate it.

It is to record, if possible, the obscured efforts, the isolated facts which finally culminated in the combinations of ideas gathered from whatever source, that are responsible for the spark-gap and coherer system of wireless telegraphy, that I have essayed the rôle of historian in which accuracy and impartialism shall be paramount.

ELECTRIC OSCILLATIONS.

Without entering into the mass of cumulative data bearing on the discovery of the laws of direct, induced and alternating currents forming, primarily, the absolute basis of wireless telegraphy as well as all else of an electrical nature, let us begin with electric oscillations.

Electric oscillations, produced by a Leyden jar or the oscillator system of an induction coil, is the fundamental factor in the art of wireless transmission of the Morse code, and it is this surging of the electric charge which causes the propagation of the electromagnetic waves through space. Following closely the discovery of this phenomenon is the action of electric waves on metal filings, and finally the details of the system.

It is almost universally ceded by scientific authorities that Joseph Henry and Hermann Von Helmholtz were the first to discover and define the nature of the restoration of equilibrium of an electrified body discharging through a disruptive spark, as in the case of a Leyden jar.

As early in the last century as 1806, the phenomenon of a "backstroke" of lighting had been observed and recorded in *Gilbert's Annalen*. The sequence of events in the history of investigation of the oscillatory discharge is as follows: In 1827 Felix Savary advanced the hypothesis of electric oscillations, having been the first to put his observations on record, based on the experimental evidence of the irregularity of the magnetization of needles by a spark from a jar.

It was not until 1842 that Henry communicated to the *American Philosophical Society* a discourse on the "Oscillations of Electrical

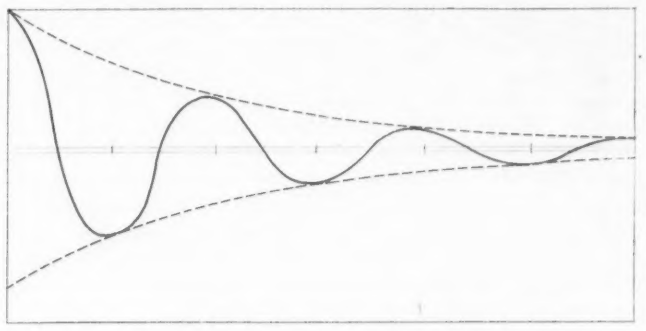


FIG. 1.—OSCILLATING E. M. F.

Discharge," advancing as a solution for the anomalies of electrical induction as exhibited in the changes of polarity in fine needles the "existence of a principle discharge in one direction and then several reflex actions backward and forward, each more feeble than the preceding, until the equilibrium is obtained." Fig. 1 shows

in rectangular co-ordinates the oscillation of a disruptive discharge from the maximum potential until its reaches zero.

Hermann Von Helmholtz, in his *Erhalting der Kraft,* published in Berlin, describes some conclusions in 1847, in which he says it is "easy to explain this law if we assume that the discharge of a Leyden jar is not a simple motion of electricity in one direction but a backward and forward motion becoming continually smaller until the entire *vis viva* is destroyed by the sum of the resistance." This conclusion was reached after Wollaston had observed that both gases were present at both electrodes in decomposing water by the disruptive discharge.

Five years later, in 1852, Sir William Thomson, now Lord Kelvin, contributed to the *Philosophical Magazine* a mathematical paper tending to prove that the disruptive discharge was oscillatory, basing his deductions on the experiment of Faraday, showing "that the electro-chemical equivalent of the whole electricity that passes appears in oxygen and hydrogen; and rising mixed from each pole, is probably due to electrical oscillations in the discharges consequent on the successive sparks."

In 1859, or thirty-two years after the report of Savary was published, Feddersen was enabled to analyze the spark by means of a rotating plane mirror (devised by Sir William Thomson and constructed by Wheatstone), breaking up the principle discharge into a series of minute sparks, and the hypothesis of Savary, experimental evidence of Henry and the mathematical deductions of Thomson, were all verified by a physical process, and electrical oscillations were placed in the category of absolute knowledge.

ELECTRIC WAVES.

The relation between the oscillations of an electrically-charged body and the waves propagated through space as a result of the dissipation of the energy of the charge is now as well known as are the laws of light waves and the atomic vibrations which produce them. However, prior to 1888 the gulf separating the mathematically predicted electric waves from the physical production of them was "wide and deep, and dark as well."

It is remarkable how often the most brilliant, learned and scientific investigator will have within his very grasp a great truth, a mighty law, a gigantic fundamental principle only to let it slip away unrealized. Electric waves until 1888 were as elusive to those who sought them as a globule of mercury to the finger's touch. But at last they were discovered and the laws governing their action determined. Without this knowledge wireless telegraphy by the present method would not be possible. The work evolving their solution is more nearly individual, and the honor belongs more clearly to one man than is usually the case in electrical arts.

But to give credit where it is due, it will not be necessary to revert further than to Faraday's discovery of the relation of light waves and the magnetic field in 1855. This he did by passing a pencil of light through the field of a powerful electromagnet with the line of wave propagation parallel to the lines of magnetic force. A cube of very dense glass placed between the poles of the magnet with an analyzer was arranged to cut off all light waves before the magnet was excited. When the magnetic lines of force were created, Faraday observed an illumination of the previously darkened field, proving that light and magnetism possessed definite relations.

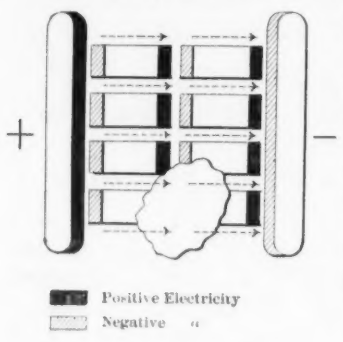


FIG. 2.—POLARIZATION OF THE ETHER.

This phenomenon led James Clerk-Maxwell, in 1865, to evolve his electromagnetic theory of light. Without reciting his theory in its complex mathematical phases or analyzing his deductions of the co-efficients of the ether, it will suffice the purpose of this paper to state simply that all forms of transverse vibrations of the ether or polarizations are the resultant of electric force separate and distinct from atomic matter. (Fig. 2.)

Primarily these polarizations are produced by changes of electric potential, and the more rapid the change or oscillation the shorter will be the wave length emitted and propagated, and the greater will be the dissipation of force in developing the electromagnetic waves.

Having determined the relative values of the period of oscillation and the emission of waves propagated by it and that the velocity of light and electromagnetic waves practically agree, it was not difficult to find justification in the belief that other and longer waves existed could they but be demonstrated.

A series of facts in triplicate, showing how a discovery "so easy seemed, once found, yet which unfound most would have thought impossible," is shown in the efforts of Hughes, Fitzgerald and Lodge.

Prof. D. E. Hughes, the discoverer of the electrical phenomenon associated with the loose contact or microphone, made a series of experiments in 1879, and ascertained that the discharge from a Leyden jar affected at a distance the loose contact or microphonic joint, causing it to cohere. Hughes opined that this result was due to electric waves capable of penetrating to considerable distances; but all his efforts, his discoveries, his ambition, which would have doubtless culminated in the honor of his having been known as the inventor of wireless telegraphy, was swept away at a single stroke by Sir George Stokes, who maintained that all the phenomena exhibited could be explained by the well-known laws of magnetic induction. This so discouraged Hughes that he made no further attempt toward the elucidation of the electric wave hypothesis, not even to the extent of placing his views on record, until at least twenty-five years after. *Hughes discovered the spark-gap and coherer system of wireless transmission, yet could not prove the existence of the waves.*

In 1883 Prof. G. F. Fitzgerald described "a method of producing electromagnetic waves by utilizing the alternating currents set up when an accumulator is discharged through a small resistance." This method was the one by which Hughes, a few years before, obtained electric waves, and it is the only method we know of to-day by which a sufficiently high frequency of oscillation may be set in motion. *Theoretically Fitzgerald knew the requirements for the production of electric waves, but was unable to construct a physical apparatus to fulfill the conditions.*

When Principal Oliver J. Lodge was engaged in the investigation of lighting rods in 1884, he likewise trod the very threshold of discovery of the electric waves; he obtained many interesting results due to electric oscillations in metal conductors, thus *producing the mechanical action of Maxwell's electromagnetic waves in neighboring wires, but Lodge did not grasp the fundamental action of these waves in space.*

It was then left for Henrich Hertz to elucidate experimentally Maxwell's theory, as modified by Helmholtz, and his own conceptions of it, and to verify it with such an abundance of physical tests that wireless telegraphy in the hands of an assiduous mechanician was made a proposition of comparative simplicity. The concise enumeration of Hertz's work relating to wireless transmission is this: (1) A method of producing electric waves by the oscillatory discharge; (2) a physical means for measuring the finite velocity of electromagnetic waves, or, as they have been termed by Hertz, electric waves; (3) the discovery of stationary waves in space, or electric radiation; (4) the experimental proof of the identity of light and electric waves by means of physical apparatus, showing all the phenomena of optics, including refraction, reflection, polarization, diffusion, absorption and wave interference; and (5) a method of detecting and measuring the electric waves. (Fig. 3.)

These were the real stepping stones to wireless telegraphy, a

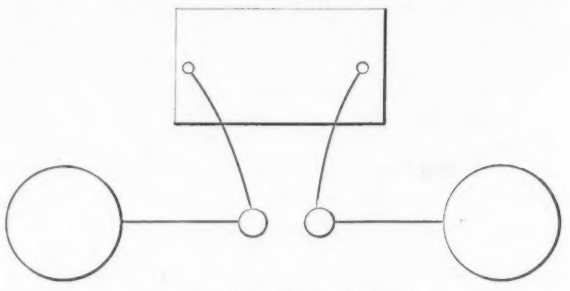


FIG. 3.—HERTZ OSCILLATOR.

greater stride toward its realization than had been made at any prior time, since his apparatus for emitting the waves, that is the induction coil, is the one in practice to-day, as are many of Hertz's electro-optical effects, which are utilized in the details of both transmitter and receiver.

To Sarrasin and de la Rive, Poincaré, Bjerknes, Righi, and the many others who have improved upon Hertz's apparatus, or who have offered additional information, wireless telegraphy does not owe much if anything, at least in its present state. Lord

Kelvin, Lodge and their mathematical and theoretical followers must needs wait a little while until the perfected system is given a commercial value before their services to the art will be recognized, and those who are first may be last and the last first.

The detector Hertz employed was merely a circle of wire with a small air-gap between its approaching terminals, and these were tipped with small brass balls; it was a device, simple and very effective in the hands of the brilliant Hertz, but as a receiver of electric waves to any commercial distance it was far too imperfect. A more sensitive instrument was needed, and it is in the evolution of the coherer, or radio-conductor, that France and England has been stirred to their very scientific depths in the desire to establish the priority of discovery for their favored sons.

ELECTRIC WAVE DETECTORS.

In a paper read before the British Association in 1870, Mr. S. A. Varley described his observations "on the opposition of a loose mass of dust composed of conducting matter to electric currents of moderate tension." Varley made a large number of experiments with lightning bridges, based on the principle of a loose contact between the terminals of the instrument to be detected, but he did not venture an explanation to account for the phenomenon.

As I stated before, in 1879 Hughes operated a wireless signal apparatus by electric waves at a distance of a mile, and there is no other substance known so sensitive to feeble electric waves or self-restoring to the degree as that possessed by powdered carbon. But he, unfortunately, did not make known this branch of experimental physics at the time. But Hughes, nevertheless, occupies the unique position in the history of wireless telegraphy by being the first to operate an emitter of electric waves and receive them by means of loose contact.

Prof. Calzecchi-Onesti, in his researches conducted in 1884, found that metal filings placed between discs of copper cohered upon the break of a primary circuit, but attributed

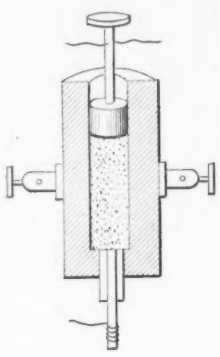


FIG. 4.—BRANLY. RADIO-CONDUCTOR.

FIG. 5.—LODGE COHERER, ¼-SIZE.

the effect to induction. With these preliminary essays in the art we now come to the last great scientific discovery that was to make the new wireless telegraphy possible.

Prof. Edouard Branly published in 1890 a complete detailed account of the "variations of conductivity under electrical influence." In this paper he describes the "effects of electric sparks on a circuit comprising a single cell, a galvanometer and some powdered metal enclosed in an ebonite tube one square centimeter in cross-section and a few centimeters in length." (Fig. 4.)

This constituted the first device designed expressly for the purpose of receiving and indicating the presence of electric waves by means of metal filings. To it Branly gave the name of radio-conductor; with it he determined within a fair degree of accuracy the relative influence of electric waves on various metals and substances. He also stated that by tapping, the tube is returned to its original resistance.

It was not until 1894 that Lodge read a paper before the Electrical Congress, pointing out the possibility of transmitting signals with the Hertz radiator and employing a modified form of the Branly radio-conductor, shown in Fig. 5. This consisted of a glass tube, having a bore of 1 cm and a length of 18 cm, the ends having conductor plugs so arranged that the pressure upon the filings could be made variable with a screw adjustment.

In his researches of the phenomena discovered by Hertz and Branly, Lodge found that the particles of metal were drawn into contact with each other, or cohered, and so he gave to the tube the name of coherer, which, though not as euphonious as the terminology of Branly, struck the keynote of popularity ,and with its new name and in its new form Lodge's name came to be inseparably linked with it. The writer has gone over all the available sources of information at his command, but has not been able to find a single reference to the Lodge coherer antedating that of the Branly radio-conductor.

Lodge was, however, the first to adopt the electro-mechanical vibrator as a means for automatically tapping the tube to effect decohesion of the filings, and this arrangement is universally in use to-day in wireless telegraphy.

ANTENNÆ AND GROUNDS.

The vertical wires, or antennæ, and the earthed connections of both receiver and transmitter for the spark-gap and coherer system of wireless telegraphy are up to the present time indispensable features

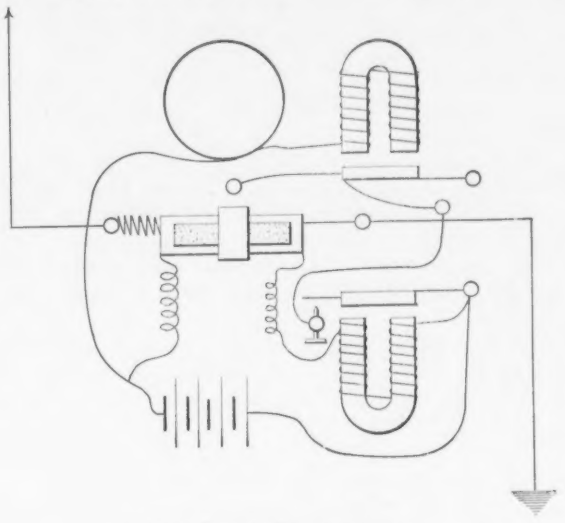


FIG. 6.—POPOFF RECEIVER.

for long-distance transmission. There seems to be no record of the antennæ, or ground wire, used on a receiving device prior to that of Prof. Popoff, the details of which he communicated to the Physico-Chemical Society in 1895 at St. Petersburg. The apparatus was not employed by him as a wireless telegraph receiver—though it could have been used as such—but to graphically plot the differences of atmospheric potential.

Popoff's reason for applying the antennæ is clear, since it follows logically that if the electrical tension of the upper strata of air is to be observed a vertical wire, or exploring rod, as Popoff termed it, must needs be extended upward into that region. The earthed wire attached to the coherer also followed in logical sequence, for a knowledge of high potentials would at once suggest the necessity for carrying away and dissipating the excessive charges by this means. Fig. 6 shows the complete arrangement of the Popoff apparatus having all the important essentials for receiving wireless messages, including the relay and an automatic (Richard's) register.

This brings the state of the art up to 1896, when William Marconi applied for his first patent in England and immediately thereafter submitted his drawings and specifications to Sir Wm. Preece, of the Postal Telegraph Service. The specifications of this patent calls for a vertical wire and an earthed plate connected with the coherer. The absolute value of the antenna does not appear to have been impressed upon its patentee until nearly a year afterward, when his long-distance experiments practically failed for want of it, and he subsequently found by the addition of a greater length of vertical wire, that the successful results depended largely upon this important factor.

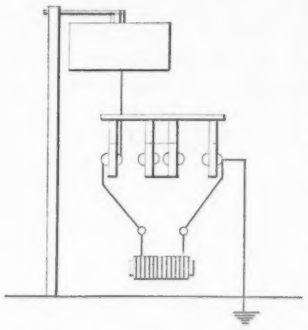


FIG. 7.—MARCONI TRANSMITTER.

The earthed wire is indispensable as well, but there is yet to be offered a satisfactory solution for its use. Different from the result attained by Popoff, the use of the vertical wire and the ground connection were, evidently not due to logical conclusions deduced from self-evident propositions by Marconi, but to his persistency of research. It would be indeed interesting to know the source of the suggestions that led him to the extenuation of the antenna and the use of the earth wire on his transmitter. (Fig. 7.)

Marconi is also entitled to the credit of having been the first to

employ the Hertz oscillator and Branly coherer in a practical working wireless telegraph apparatus. Lodge operated the system to obtain signals before Marconi, from a purely scientific standpoint, but offered no information that has influenced the present situation, excepting, perhaps, that given by his automatic decoherer.

The third distinctive claim to which Marconi is entitled is his improvement in the coherer. This, however, cannot be classed as either an invention or discovery in the true sense of these words, but is, nevertheless, responsible, to a very great extent, for the present status of the art. A summation of the genesis of wireless telegraphy up to 1897, when Marconi produced a working system from a chaos of uncollected data, may be thus briefly stated: To those who ascertained the laws and constructed physical apparatus such as the Ruhmkorff coil, the voltaic cell and the electro-mechanical devices required for the new telegraphy, the measure of their services is already known.

To Hertz, Branly, and, finally, Marconi, the laurel wreath of success should be bestowed without fear, without favor, for to their genius are we indebted for the marvelous instruments capable of emitting and propagating electric waves through space, and a receiver of such super-sensitiveness that the feeblest wave impinging upon it would be registered and automatically translated into an intelligible code.

To Sir William Preece belongs a unique place in the development of the art, or for that matter in the history of invention. Himself an inventor of the electromagnetic induction system of space telegraphy, he was broad enough to recognize in Marconi's experiments a system superior to his own.

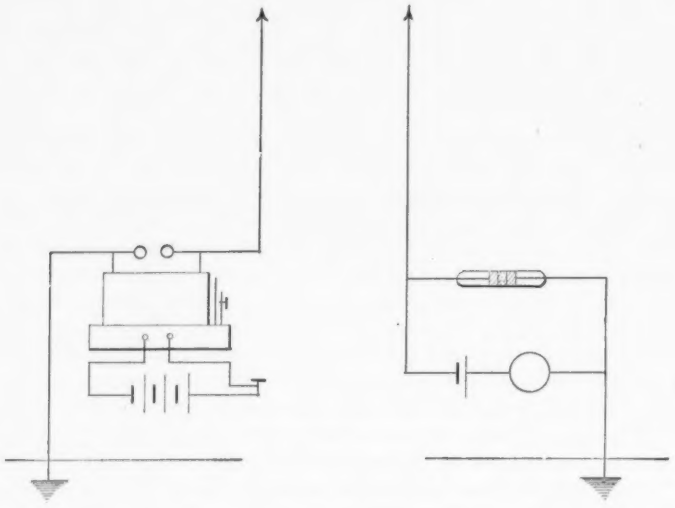


FIG. 8.—THE EVOLVED WIRELESS TELEGRAPH.

Lodge, Slaby and a host of other investigators in the etheric vineyard have little title in the present system that has carried an electric wave over a distance of 2,000 miles. But wireless telegraphy is, even yet, in a certain state of crudity, for without syntonization it must always remain limited in its application. It is in this especial field that the mathematical elucidation of the phenomena of the ether, the element of time for each oscillation, the values of resistance, capacity and inductance—all these determine the wave length—and syntonization has been shown to be capable of solution along these lines.

When syntonic wireless telegraphy is really accomplished a large portion of the present history will have to be interpolated with the excellent work of those referred to, and a new name chosen to "lead all the rest."

The genesis of wireless transmission is the prototype of all human progress that finds its climax in invention and discovery. The question is whose name should stand as a symbol of the art it represents. He who made the first obscured effort, he who worked out the greatest principle, or he who picked the brains of the world and produced a work that would withstand the time-stamp of commercialism? It is usually the latter, and justly, that reaps the dual reward of finance and fame. All who have contributed their mite, however, are entitled to their proper places in this royal coronation procession, and precedence should be given to those accounted best.

The Application of Electricity in Steel and Iron Mills.

BY C. H. HINES.

AMONG the notable instances of the growth of the electrical industry is its application to the operation of the great steel and iron works of to-day, and its rapid increase and varied uses in such works.

Taking one plant that I have in mind which started with a 20-hp bipolar T. H. generator operating one crane a little over seven years ago, the same plant now uses 2,000 kw of power, which does almost the entire work of the plant, save operating the main rolls. Cranes, strippers, tables, blowers, charging cranes, pig casting machines, coal crushers, hoists and the pumps for supplying to the boshes of the furnaces are all operated by electric motors, while the ore, coke and limestone with which they are charged are handled by the same means. Among the minor applications are included telephone clocks, time detectors, automatic indicators, magnetic separators; electricity is even in the laboratory for chemical analysis and other operations, while for burning out chilled iron the skill of the electrician is sometimes called into play. And all these appliances are called on to do their work day and night, under the most adverse conditions in many cases; handled largely by unskilled labor, and doing work that would cause the average central station man to groan in spirit. Yet with all this they do their work so unfailingly that it is only when an important piece of mechanism stops for a brief period that the necessity of the electrical department is recognized. Moreover, the cost of repairs is far below that which would be required by a steam plant doing the same work.

In the plant that I have mentioned the 2,000 kw of power consists of 10 units, and the 5,000 hp of motors are in 200 units ranging from ½ to 150 hp. Two armature winders keep up all the necessary repairs to the armatures, as well as making up nearly all the coils required for repairs and re-winding.

One important factor which has not yet entered into the operation of these plants is the storage battery, and where the load is always fluctuating, as it is in these cases, they could be most profitably employed. As spare generators are not as frequent as in central stations, their value in the case of a temporary breakdown of a generating unit would more than compensate for their cost.

A crying need also for these plants is a controller that will stand the constant abuse and reversals to which they are subjected. While many improvements have been made along this line the desired end has not yet been attained, but is, I hope, very near. Another need is a good brush holder adapted to stand the same treatment; for of all the many forms that are now used none is quite satisfactory.

I have found in estimating on the size of motors in connection with this class of work that it is always wise to figure on at least 25 per cent. greater capacity than is actually required, except in the most favorable locations. While by this method the greatest economy is not secured, yet the loss in efficiency is more than compensated for by the decreased danger of burn-outs and delays; for in steel works the entire ten commandments of operation are comprised in the words, "Thou shalt not break down or delay production."

A shut down of but an hour or so, if it affects the production, such as a deranged crane in the bottom house, means a loss in dollars far in excess of any economy of operation.

In most of the mills of the present day direct current at a voltage of 250 is commonly used. Most of these plants were started in a small way electrically and have constantly been added to, but in the most modern ones that are now building the alternating current has entered the field, and has come to stay. It does all that direct current can do, without the annoyance of commutator trouble, while its flexibility adapts it to all uses. As almost all the works of a steel plant are bunched in a comparatively small area, a low voltage can be used and the bugaboo of greater danger thus removed.

Alternators of a low frequency of about 25 cycles and ranging from 400 to 600 volts are best adapted to this class of work, as this permits the use of induction motors without the expense and losses of a cumbersome transformer system; while for the non-inductive load or lighting load, which rarely exceeds 15 per cent. of the total load, motor generators take care of and supply series arc lamps for the lighting.

Another point to be considered is the possibility of utilizing the gases from the furnaces direct in gas engines driving the generators. With the low frequency mentioned there is no reason why with the

present gas engine this cannot be done with a vast increase of economy of operation.

There are many other lines that might be followed out with profit. Many cranes employed in the handling of sheets of steel and iron and other heavy material could be equipped with portative magnets, thereby saving time and labor. All these things are bound to come in due time; indeed many of them are even now here, or in the projected plans of new structures, and the day is not far distant when the electrical department of the steel mill will be recognized as its most important feature.

In conclusion, it will not be amiss to say a few words regarding the man whose skill and knowledge is looked to to direct these operations. The position of the chief electrician in steel plants is vastly different from the central station man, or a similar position in other branches of the electrical industry. He must not only understand his routine work thoroughly and have a well grounded technical knowledge, but must also be of an inventive turn of mind, as he is constantly called upon to devise some new method of harnessing the power he controls and must meet the demand promptly, be prepared for any emergency that may arise day or night. In addition to his resourcefulness he must have infinite tact and patience, since the major part of his working force is recruited from unskilled material.

Nickel Steel and Magnetic Observation.

BY CRITTENDEN MARRIOTT.

IN the opinion of officers of the United States Coast and Geodetic Survey, the discovery, by C. E. Guillaume, of the International Bureau of Standards, of the very peculiar magnetic properties possessed by nickel steel alloys containing from 15 to 25 per cent. of nickel, is likely to simplify amazingly all measurements of terrestrial magnetism, as well as all comparative galvanometric observations in which extreme accuracy is required. The use of these alloys will, it is believed, prevent changes of temperature from causing changes in the moment of the magnet itself, and thus do away with the immense amount of calculation now required to eliminate the error due to this cause.

Comparatively little is known in this country regarding high percentage nickel steels, only low percentage ones having been used to any extent here, and even these not as often as their good qualities would seem to justify. In France, however, investigators have been working on them for some years and have attained surprising results, discovering that alloys with less than 25 per cent. of nickel possess two curves of magnetic transformation, between which their state depends solely on which curve they have last cut and the place at which they cut it. According as this may be, they are either permanently non-magnetic, or possess a degree of magnetism which is not alterable by any change of temperature not great enough to cause them to cut one of the curves.

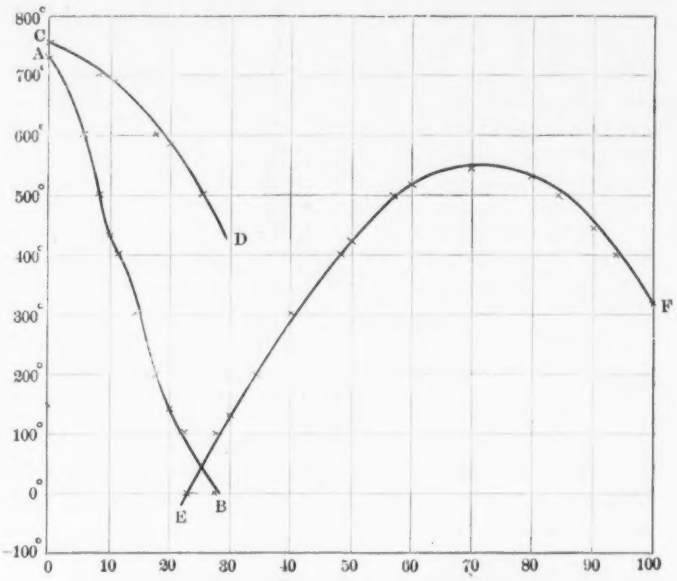
Alloys of more than 25 per cent., on the other hand, follow the usual law, becoming increasingly magnetic as their temperature drops and decreasingly so as it rises, the point where all magnetism is lost depending on the percentage of nickel they contain. These alloys M. Guillaume has christened "alterables"; the former class he calls "unalterables." In the accompanying figure, *AB* is the lower limiting curve of an unalterable alloy; *CD* the upper limiting curve, and *EF* the point of change of alterable alloys.

The very peculiar qualities of the unalterable alloys are best explained by an example. One with 24 per cent. of nickel, for instance, may be either non-magnetic, or may possess a degree of magnetism which is unalterable for any change of temperature between 0° and + 450° Centigrade. Hot from the crucible, it is non-magnetic, and so remains until its temperature has dropped to 0°, when it begins to gain magnetism, attaining a maximum at about —200°. If heated again, it retains its full magnetism until raised to + 450°, when it begins to lose and becomes altogether destitute at about + 650°, so remaining until again reduced to 0°. If the heating or cooling is stopped at any intermediate point (say at — 100° or + 500°) and then reversed, the alloy retains the exact degree of magnetism which it possessed when the reversal took place.

For 24 per cent. of nickel the limits are 0° and + 450°; as the percentage is decreased, both limits rise, the upper slowly, the lower one rapidly, moving up about 30° C. for each 1 per cent. of nickel reduction. At 12½ per cent. the limits are about + 400° and + 650°, both far beyond any ordinary temperature. Therefore, a 12½ per cent. alloy is always below the lower limit, and consequently seems always magnetic. Nevertheless, there is a range of 250° of temperature (from + 400° to + 650°), where it may be magnetic or non-magnetic according to whether it was heated or cooled in order to reach it.

The limits as given are those at which magnetization begins to appear or disappear; the points at which it has fully appeared or disappeared are removed about 200° further apart at each end. If a fully magnetized alloy is required that shall remain unalterable at all ordinary temperatures, one whose point of change is about —230° would seem to be indicated. This would be attained with about 16 per cent. of nickel, a proportion which is supposed to be about that required for nickel steel to be used in magnetic measurement. Further experiments will be required to definitely settle this point.

These figures are strictly applicable only when no other elements than nickel and steel are present. If a small amount of chrome is added, the effect is to reduce the lower limits of the unalterable



MAGNETIZATION CURVES OF NICKEL-STEEL ALLOYS.

area. Thus 3 per cent. of chrome added to a 22 per cent. nickel alloy so reduces the lower limit that even liquid air is not cold enough to cause the shift to the magnetic state, and the alloy (which of course came non-magnetic from the crucible) can never be magnetized. If 3 per cent. of nickel had been added instead of 3 per cent. of chrome, the alloy would have become an "alterable," and would have been magnetized at about 0°. Lower percentages than 25 can thus be kept non-magnetic at ordinary temperatures by the addition of varying amounts of chrome. In other words, by proper additions the range of temperature within which the alloy is unalterable can be shifted almost at will, and the point at which any desired degree of magnetism is conferred can be brought to any convenient point.

Edison and Norway.

A special cable dispatch from London to a New York newspaper, dated May 4, says: It is many months now since it was reported that a body of British ironmasters had been attempting in Norway, with the co-operation of Mr. Edison, to meet the deterioration in Bilbao ores, and in a measure to combat the situation created by the establishment of the United States Steel Corporation. The result is now announced in the prospectus of the Dunderland Iron Ore Company, which has been formed, with a capital of £2,000,000, to work extensive deposits of iron ore in Norway by means of Mr. Edison's process. The enterprise is placed before the British public, backed by names of power and influence. The chairman is Sir David Dale, managing director of the great Pease firm, whose word is as readily acceptable in the North of England as a note of the Bank of England. The technical advisers of the company include Mr. Edison and Lord Kelvin.

The Synchronous Converter as Voltage Controller.—II.

(Concluded.)

BY M. SEIDNER.

SO far, I have developed how a projected power transmission system operates under varying loads. In the following is to be shown how the different quantities are to be selected, so as to give the system certain desirable properties.

One of the most important quantities is the proportion of the alternator and converter voltage $\frac{E}{e}$. The determination of the absolute value of the voltages and the other quantities does not come within the scope of this article. The changing of this proportion by the variation of the voltage e causes a shifting of point O on the impedance line $O\,Z$ in a circuit with fixed E, resistances and reactances (Fig. 6). All points on the characteristic circle travel with the same velocity and in the same direction. The maximum power transmitted under these conditions with a certain

$e = O\,O_1 = O_x\,P_m$ is

$$a = \frac{P_m H_m}{Z}\,e = \frac{P_m O_1 - O_1 H_m}{Z}\,e = \frac{E - e\cos a}{Z}\,e$$

This power becomes a maximum for the voltage e, which annuls the first differential quotient:

$$\frac{da}{de} = \frac{E}{Z} - 2\,e\,\frac{\cos a}{Z} = 0$$

$$e = \frac{E}{2\cos a}, \text{ and}$$

$$a_{max} = \frac{E^2}{4Z\cos a} = \frac{e^2\cos a}{Z}$$

The phase difference for this maximum power is

$$\tan \varphi = \frac{H_m O}{H_m P_m} = \frac{e\sin a}{E - e\cos a} = \frac{e\sin a}{2e\cos a - e\cos a} = \frac{e\sin a}{e\cos a} = \tan a$$

$$\varphi = a$$

The co-phase current $\frac{O\,P_x}{Z}$ is determined by the equation,

$$E^2 = e^2 \sin^2 a + (O\,P_x + e\cos a)^2,$$

and the current $\frac{O P_\circ}{Z}$, lagging by a quarter period,

$$E^2 = e^2\cos^2 a + (e\sin a + O\,P_\circ)^2.$$

With the ruler and compasses we can substitute plain diagrams for these complicated equations. By varying the voltage e, Pm travels on the line $O_x\,E$ and, therefore, $O\,O_x = E$ and arc $\tan \frac{O\,E}{O\,O_x}$ = impedance angle (Fig. 6). The maximum power transmitted with a certain $e = O_x\,P_m$ is

$$a = \frac{P_m H_m}{Z}\,e = \frac{P_m H_m e\sin a}{Z\sin a} = \frac{P_m H_m H_m O}{Z\sin a} = \frac{P_m H_m O\,B}{Z\sin a}$$

In other words, the maximum value of a for a certain $e = O_x\,P_m$ and a is proportional to the rectangle $P_m\,H_m\,O\,B$. The current corresponding to this, its energy and wattless components, can be taken from the diagram. Drawing a circle with the radius $O_x\,O = E$ and O_x its center, it can be seen at a glance that $P_m C = O\,P_x$ = co-phase current, and $P_m\,D = O\,P_\circ$ = current lagging by a quarter period. The following is an explanation of the quantities of Fig. 6:

$O\,O_x = E$ = constant.

$P_m O_x = e$ = variable.

a = impedance angle = constant.

$\frac{P_m\,O}{Z}$ = current for maximum output at a certain $e = O_x\,P_m$.

$\frac{P_m H_m}{Z}$ = energy component of current.

$\frac{P_m B}{Z}$ = wattless component of current.

$P_m O\,O_x$ = phase difference at receiver end.

$\frac{P_m C}{Z}$ = co-phase current.

$\frac{P_m D}{Z}$ = current lagging 90 degs.

$\frac{P_m H_m O\,B}{Z\sin a}$ = maximum output for $e = O x P_m$.

$\frac{A B P_m C}{Z\sin a}$ = co-phase output for $e = O x P_m$.

$\frac{A C H_m O}{Z\sin a}$ = overload capacity.

The diagram relating to the influence of the converter voltage e is readily understood. We endeavor to keep e as high as possible, to

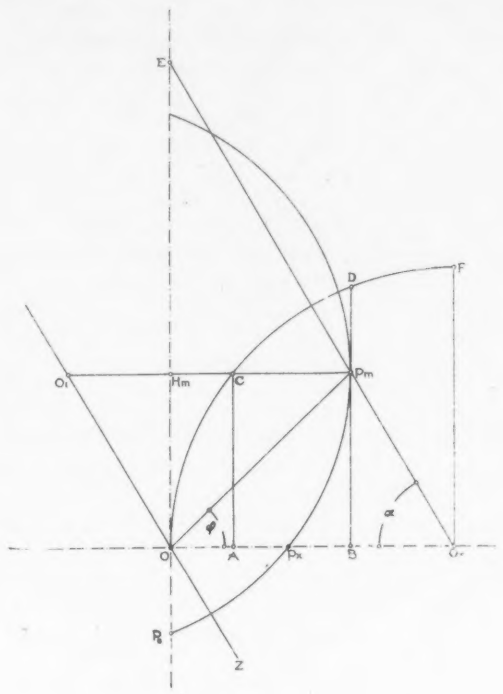


FIG. 6.

operate with small currents. But increasing it to the alternator voltage reacts as detrimental to the system, as well as decreasing it below certain limits. If $e = 0$, P_m coincides with O_x, C with O and D with F. The alternator energy is consumed in the line. In this case the theoretical maximum energy is transmitted to the converter by a co-phase current. The system now can operate only with lagging currents, the leading currents cause it to become unstable. Increasing the voltage e, the maximum output taken by the converter increases,

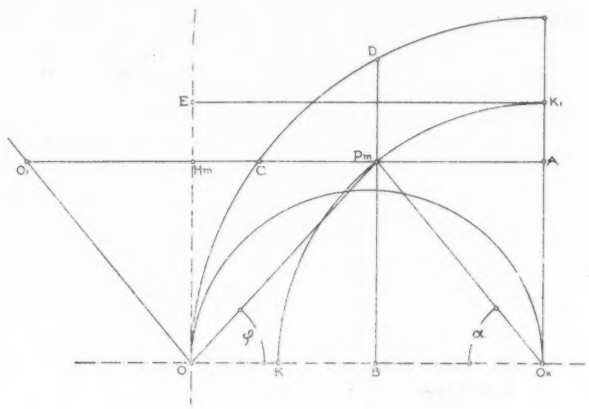


FIG. 7.

but the power factor for this maximum output decreases rapidly. The possible maximum output is reached when $e = \frac{E}{2\cos a}$. In this case the rectangle $P_m\,H_m\,O\,B$ has its maximum area. For this $\phi = a$. If $e = E$, P_m will coincide with C at D; the co-phase current and that lagging 90 degs. disappear, and the system is capable to operate only with leading currents.

Increasing the voltage has a great influence on the no-load current. $Tan\ P_m C\,D = \frac{no\text{-}load\ current}{co\text{-}phase\ current}$ corresponds for $e = 0$ to 45

degs. and varies with e; for $e = E$ it attains its limit value $(90 - a)$. Therefore, as $a \lessgtr 45$ degs., the no-load current increases, remains constant, or decreases with increasing e. There we see the decisive influence of the impedance angle a on the no-load current; by increasing a this current can be decreased as one desires.

The impedance angle a can be altered in three different ways. First, at constant impedance; second, at constant reactance, and, third, at constant resistance.

If the voltage e is kept constant, P_m of the characteristic circle travels on circle $K - K$, as a varies (Fig. 7). Then $O\,O_x = E$, and $O_x\,P_m = O_x\,K = e$. The maximum energy for a certain a is

$$a = \frac{P_m H_m}{Z}\,e. \quad \text{If } Z = \text{constant}, \; a = P_m H_m\,\frac{e}{Z}$$

or, in other words, the maximum energy transmitted to the synchronous converter is proportional to the length $P_m H_m$. If the reactance x remains unaltered,

$$Z = \frac{x}{\sin a}, \text{ and } a = \frac{P_m H_m}{x}\,e \sin a = \frac{P_m\,H_m\,P_m\,B}{x},$$

i. e., the maximum power is proportional to the rectangle $O\,B\,P_m H_m$. If the resistance r is kept constant,

$$Z = \frac{r}{\cos a}, \text{ and } a = \frac{P_m\,H_m\,e\cos a}{r} = \frac{P_m H_m\,P_m\,A}{r}.$$

By drawing a circle with a radius $O\,O_x = E$, and O_x as center, we get $\frac{P_m C}{Z}$ = co-phase current; $\frac{P_m D}{Z}$ = current lagging 90 degs.

For Z = constant, $P_m C$, and, therefore, $P_m D$ is proportional to the corresponding currents,

for x = constant they are equal to $\frac{P_m C \times P_m A}{e\,x}$ or to $\frac{P_m D \;\; P_m A}{e\,x}$;

for r = constant they are equal to $\frac{P_m C \times P_m B}{e\,r}$ or to $\frac{P_m D\,P_m B}{e\,r}$.

The influence of the impedance angle a is explained according to the diagram, as follows: If a varies from O to 90 degs., the maximum power with constant z grows from $\frac{O\,K}{Z}\,e$ to $\frac{E\,K_1}{Z}\,e$;

with constant X grows from 0 to $\frac{O\,E\,K_1\,O_x}{x}$; and

with constant r grows from $\frac{O\,K \times O_x\,K}{r}$

to a maximum, and decreases to 0. This maximum is reached when $H_m P_m = P_m A$.

The relation of the co-phase current to that lagging 90 degs., varying the angle a from 0 deg. to 90 degs., increases in the three instances to the reciprocal value. If $e = E$, this relation increases from 0 to a.

The phase difference ϕ of the current corresponding to the maximum output increases from 0 to a limit, for which $(\phi + a) = 90$. Beyond this value the phase difference diminishes, but the power taken may be increasing. The semi-circle $O\,O_x$ is the geometrical path of these points, which determine the maximum phase difference for all e from 0 to E. Increasing the impedance angle, therefore, has a similar effect as increasing e. But while the increase of e results in a steady increase of phase difference, the increase of a may diminish it.

The valuable influence of the impedance angle on the elasticity of the system, on the no-load current and on the power factor, explains the tendency to make the system highly reactive by inserting additional reactances. But while a heavy reactance from this point of view appears advantageous to the system, by inserting such additional reactances we must not ignore other directive phenomena, as the requirements of parallel running of synchronous machines, and the danger which arises from the electromagnetic inertia of a system heavily loaded with reactance.

Being familiar with the influence of the different quantities upon the diagram, after careful observation of the special conditions, it is a matter of experimental combination to decide upon the location of the characteristic circle in each particular case. It is generally preferable to give the characteristic circle such a position that it expresses the normal load with minimum current, that is, the converter runs non-inductively at normal load; consequently, the point P_m, indicating the maximum output, should be so located that the output is flexible enough with leading, as well as with lagging currents, without seriously disturbing the limits of the normal capacity with low-power factors. Care should be taken also to release the system from heavy no-load currents. By substituting the alternator terminal voltage for the induced e. m. f. in the foregoing graphical treatment, we get the solution of the other problem, that of constant alternator terminal voltage at constant receiver voltage, without further means. Moreover, the above graphical solution can also be adapted to the similar problem of compensating alternators.

The Economic Design and Management of Telephone Exchanges—XI.

BY ARTHUR V. ABBOTT, C. E.

THE RELATION BETWEEN THE NUMBER OF OFFICES AND THE MILEAGE OF THE TRUNK LINE PLANT.

WHEN any territory is served by a single office, each sub-station may be immediately placed in talking relations with any other one in the whole group by the simple process of interconnecting the two sub-station lines by a flexible cord; for on the single office multiple switchboard system, every subscriber's line is within the reach of any operator. But when a given territory is subdivided, and has more than one office, it is no longer possible to interconnect all sub-stations, for the lines of some will converge to, and terminate in, one of the offices, while others will end in some other office. It is therefore necessary to provide some means, whereby stations tributary to one office that desire communication with those ending in any other office, may be accommodated. This is accomplished by providing between all of the various offices taken in pairs a set of special wires called *trunk lines.*

It has been shown that the total sub-station mileage for any territory decreases rapidly as the group is subdivided into smaller and smaller portions; but it is evident that this very endeavor to minimize sub-station mileage will be accomplished with a multiplication of trunk lines, for with each additional subdivision another office is added, from which, to all other offices, trunk lines must be provided. Further, the smaller the portion of any territory that is served by any one office the larger will be the portion of the exchange foreign to it, and the greater will be the probability that sub-stations will desire to talk outside, and not inside, of the boundaries of the office in which they terminate. So as sub-station mileage is decreased, by subdividing any territory, trunk line mileage is increased, and it is easily imaginable that the process of subdivision could be carried to such an excess as to cause the increments of trunk mileage to overbalance and exceed the decrements of sub-station mileage. Evidently the true minimum total wire mileage in any case is secured by making the sum of all sub-station mileage, plus that of all trunk line mileage a minimum, and the method of discovering this condition must now be described.

The total trunk-line mileage in any territory, will be proportional to the number of trunk lines needed, and to their length. The number of lines required will depend upon the volume of business to be carried, and a factor that might be termed the *Specific Trunking Capacity,* or, in other words, the number of messages per unit of time that it is practical for a trunk line to transmit. The volume of business will depend upon the number of sub-stations; the number of messages originated per unit of time, per station, and the ratio of the number of messages sent outside of the office under consideration to the total number originated. The length of the trunk lines will depend on the size of the exchange, and the number of offices into which it is split. Let S represent the number of sub-stations in any exchange, and T the average number of originating messages per day, then TS will be the total number of messages originated; this quantity is usually called the *Originating Traffic.* Let S' and T', and S'' and T'', etc., represent respectively the number of sub-stations, and their daily average originating messages, in the various offices into which the exchange may be sub-divided, then $S'\,T'$ and $S''\,T''$, etc., will denote the originating traffic of each of the individual offices. Let R' and R'', etc., represent the ratio of the messages sent out of offices S', S'', etc., to their originating traffics, then $R'\,S'\,T'$ and $R''\,S''\,T''$, etc., will denote the daily business sent out of the offices S', S'', etc. For brevity it is convenient to call this quantity the *Out Trunk Traffic.* If Q stands for the Specific Trunking capacity per line per day $\frac{R'\,S'\,T'}{Q}$; $\frac{R''\,S''\,T''}{Q}$ etc., will be the number of trunk lines needed for the offices S', S'', etc., to all the rest of the exchange

and $\frac{R' T'}{Q}$, $\frac{R'' T''}{Q}$, etc., will be the number of trunk lines per sub-station in the several offices. For brevity call these quantities respectively the *Office Trunkage and the Subscribers' Trunkage.* If L' and L'', etc., denote the average length in miles of the trunk lines from the offices S', S'', etc., to all other offices, then $\frac{R' S' T' L'}{Q}$ $\frac{R'' S'' T'' L''}{Q}$, etc., is the trunk line mileage from offices S', S'', etc., to all other offices, call this quantity the *"Trunk lineage"* then $\frac{R' T' L'}{Q}$ and $\frac{R'' T'' L''}{Q}$ etc., is the *Trunk lineage per sub-station.* For every exchange the proceeding quantities S T, S' T', etc., R Q and L will have certain specific and definite values which must be ascertained and used in order to secure the best design. But average values derived from extended experience will best exemplify the method of calculation, and will yield probable average results, that may be taken as general guides.

The values of S and T will vary with the size of the city under consideration. From present indications it seems quite certain that cities of 500,000 population and over will soon have at least 40,000 to 50,000 subscribers. Those of 200,000 to 300,000 inhabitants from 20,000 to 30,000 telephones, while towns of 75,000 to 100,000 people should be credited with not less than 10,000 stations. It is difficult and somewhat hazardous to assign a value to T on account of the rapidly changing character of the telephone business. As an exchange grows in size the increasing number of subscribers give greater and greater opportunities for conversation, and if all parties equally availed themselves of this possibility, the traffic would vary with the square of the number of sub-stations. But this is never the case; on the contrary, increase in traffic rarely keeps pace with the increase in sub-stations. The depression in the traffic rate is partly due to the fact that people having the greatest amount of telephone business are the first ones to subscribe, while those less telephonically busy come in afterward; and partly owing to the recent introduction of the coin box, slot machine and nickle telephone, or other forms of measured service which are rapidly creating a very large telephonic population who wish to "pay as they go," and are strongly averse to the contract, and flat rate system. With the flat rate method there is no incentive to any economy in traffic; and the subscriber, his friends, acquaintances and employes use the instrument *ad libitum.* But with any form of measured service, where the rental is at least in some degree proportional to the traffic, there is a strong motive for economy in the use of the instrument, a most powerful factor to depress the call rate. Taking all things into consideration, it seems probable that even the busy offices in the center of the largest cities will not average over twenty originating messages per day, while those in the residence districts, or on the outskirts should be credited with ten. For offices similarly located in medium sized cities a message rate respectively of sixteen and eight will be assumed, while for towns from 75,000 to 100,000 ten messages per station per day seems fair.

As any district is repeatedly sub-divided into a constantly increasing number of offices the size of each office and the number of sub-stations it contains constantly diminishes. Therefore S, or the number of sub-stations, etc., is the independent variable in both the trunk line and sub-station line problem, and will, for this part of the discussion, be assumed to vary from 500 to 7000, as it seems that smaller offices than 500 would never be considered, and that the economy of those larger than 7000 is certainly doubtful, as there is no American experience with central stations even of this magnitude.

The value of R represents the proportion of the originating messages that any office will send beyond its boundary lines. If it should be assumed that each subscriber in all of the various offices into which any territory may be divided originates an equal number of messages, and further, that each subscriber transacts an equal amount of business with every other subscriber, the messages trunked out of any one of the separate offices will bear the same ratio to the total messages originated by all the subscribers in the office under consideration, that the sum of the subscribers in the given office bears to the sum of all the subscribers in all the offices. So if S be the total number of sub-stations in the entire territory, and S' the number in any particular office, then under the preceding hypotheses, the percentage of messages trunked out of the particular office will be $\frac{S - S'}{S}$. This is a ratio, but if T' be the average number of originating messages in the office in question S' T' will be the total number of messages originated by the office, and then $\frac{(S - S')}{S} \frac{S' T'}{}$ will be the out-trunk traffic. This formula assumes an equality in traffic over the whole exchange, but if the average traffic T' of the office S' differs from the average traffic T of the whole territory this discrepancy must be recognized by introducing the factor T' as follows:

$$\frac{S T - S' T'}{S T} S' T', \text{ or } \frac{S S' T T' - S'^2 T'^2}{S T}$$

which gives the out-trunk traffic of the office under consideration.

The preceding formula is based on the assumption that each person will always send an equal number of messages to all others. Such an hypothesis could only be true in a case where every individual was acquainted with, and equally interested in every other one in the whole community. In small villages the condition of equality of traffic is sometimes approximately realized, for in such cases every one is apt to know, and likely to have some dealing with all others. But in cities, particularly the larger ones, groups are formed, each one gathering around him a particular circle of friends, acquaintances and business associates, and ignoring all others, thus the telephonic business of each individual flows in certain well defined channels from which it rarely and only spasmodically departs. But owing to the complexness of society there is a constant overlapping of the acquaintance circles. Thus A and B are mutual acquaintances, and each knows a hundred other people. Of the hundred in A's circle B is acquainted with fifty, and of the hundred in B's circle A knows fifty. A and B talk together, B talks to fifty people outside A's circle, and A talks to fifty outside of B's circle; each talks to a hundred mutual acquaintances; and neither A or B send any amount of business to the great mass of sub-stations outside the limits of their particular coteries. To recognize this condition it is necessary to introduce in the preceding expression, a coefficient that may be denominated the *"Acquaintance factor."* If q represents this factor the actual out-trunk traffic will be ascertained by the formula

$$\frac{q (S T - S' T') S' T'}{S T}$$

The value of q varies between quite wide limits. In cases where there are two or three offices of nearly equal size and serving similar districts about 68 per cent will hold true. When there are several small offices on the outskirts working into larger ones near the center 85 per cent to 95 per cent will represent q for the smaller offices, and 60 to 65 per cent for the large ones. In the cases of a number of medium-sized offices 70 per cent to 80 per cent is a fair average. While in the extreme of one large office and one small one 40 per cent to 50 per cent will indicate the factor for the large one and 92 per cent to 98 per cent for the small one.

The preceding expression will give such a value for the trunk traffic as would exist if the incoming and outgoing messages were always numerically equal in each office, and here a misconception often arises. Take, for example, an exchange of two offices. One, A, in the center, and the other, B, in the outskirts of a large town. Suppose A send B ten messages, and B send A one hundred; there will be a total one one hundred and ten outgoing trunk messages and one hundred and ten incoming trunk messages, but the incoming trunk messages *in* A will be ten times as great as the incoming messages *in* B. In the formula the only known quantities are the number of stations in the whole exchange and average message rate; also the number of stations and average call rate in the particular office under consideration. Therefore the formula gives the mean value between the numbers the numbers representing the incoming and outgoing trunk messages. Usually the difference is very slight, not more than three or four per cent, and it is only in case of a very large office and a very small one that any practical difference would exist. If there *is* a sensible difference between the incoming and outgoing messages it is possible to more closely approximate to the true value by adding or subtracting from the result given by the formula, such a quantity as will recognize this difference. The total number of originating messages is the only known quantity, hence the desired correction must be expressed as a percentage thereof. Let p be the percentage then $\frac{p (S' T')}{100}$ will be a quantity either to be added to or subtracted from the mean value in order to ascertain the desired true number

of out-trunk messages. This correction must be additive in cases where the outgoing work is in excess of the average and subtractive where it is deficient.

The complete expression for the out-trunk traffic is therefore:

$$\frac{q\,(S\,T - S'\,T')\,S'\,T'}{S\,T} \pm \frac{p\,(S'\,T')}{100};$$

but usually sufficient accuracy is obtained by using the abbreviated form,

$$\frac{q\,(S - S')}{S}\,S'\,T';$$

in which q has a value ranging from .65 to .85, depending upon the relative sizes of the offices S and S', and from these expressions the following values for R are immediately deducted.

$$R = \frac{q\,(S\,T - S'\,T')}{S\,T} \text{ or } R = \frac{q\,(S - S')}{S}$$

The Isolated Plant versus the Central Station—Discussion at the Chicago Electrical Association.

The evening of May 2 was given over to a discussion of the isolated plant versus the central station, at the Chicago Electrical Association. The meeting proved to be a very interesting one, and the discussion was at all times animated and full of good points.

To start the discussion, Mr. C. A. Dresser presented some figures on the probable cost of installation and operation of a certain size of isolated plant. Mr. Dresser introduced these figures by saying that there was nothing positive in his own conviction regarding the advisability of the isolated plant where central station service could be obtained. There were undoubtedly places where isolated plants could furnish current cheaper, and also cases where it could be better supplied by central station. No one case either way proves anything as to the general proposition. In order to discuss the matter some hypothetical case must be assumed, and he assumed a plant which would have a load of 80 hp for 10 hours per day, 300 days a year.

For this plant he assumed it would be necessary to put in a capacity of 100 hp in a single unit. The cost of soft coal suitable for the Chicago isolated plant is $2.50 per ton. In a plant of this kind an evaporation of 6 pounds of water per pound of coal is a safe estimate as to commercial possibilities. The cost of water in Chicago is 10 cents per 1,000 gallons. He assumed that one man could operate this plant and that a licensed engineer for this purpose could be obtained for $75 per month. The load he assumed to be 80 indicated hp for 300 days in the year, 10 hours per day, or 240,000 indicated hp-hours per year. He assumed that the simple high-speed engine used in such a plant would require 40 pounds of water per indicated hp hour, which with an evaporation of 6 pounds of water per pound of coal would call for 6⅔ pounds of coal per indicated hp-hour, or 750 tons per year, or say, 800 tons including everything, which, at $2.50 per ton, would cost $2,000. Water consumption on the same basis would be 1,152,000 gallons per year, or $115. Oil, waste and supplies he figured at $300 per year. The engineer would cost $900 per year. The cost of such an isolated plant of 100 hp capacity with one engine and one boiler, he assumed at $6,000. Ten per cent. depreciation on this would be $600 per year, and interest at 6 per cent., $360 per year. Cost of rent and insurance were assumed at $100 a year, making the total operating expenses and fixed charges $4,375 per year. Figuring a load of 80 hp, 10 hours per day for 300 days, the cost per indicated hp-hour would be $0.0182. He assumed that since the efficiency would not be very high in a small plant of this kind, 1 kw would require 1.8 indicated hp for its development. This would make the cost 3.27 cents per kw-hour.

As to the matter of exhaust steam heating, which could be done from this plant, he said, it is customary to estimate that the exhaust from 1 hp would heat 100 sq. ft. of radiating surface and 8,000 sq. ft. would, therefore, be available from 80 hp. One sq. ft. of radiating surface will heat 100 cubic feet of space in a factory such as this plant would be installed in, and the amount of space which could be heated from the 80 hp would be very nearly the capacity of a general factory building, which would install an isolated plant of this kind. If the factory was heated by direct steam, one-third pound of coal per sq. ft. of radiating surface per day would be required. He figured that the cost of coal for heating would amount to at least $100 per year on this basis, and the fireman during the heating season would cost $300. The cost of the boilers for heat would be $800, upon which the depreciation at 10 per cent. would be $80. Figuring in incidentals connected with heating, the cost would be $1,028 per year for heating alone, if there were no isolated plant. Deducting this from the cost of operating, the isolated plant would bring the cost of power down to $0.0014 per indicated hp-hour, or $0.025 per kw-hour. However, Mr. Dresser considered this to be rather of an extreme case, for the average load is too high in proportion to the maximum capacity of the plant. In order to provide against breakdowns it would probably be necessary to put in a plant of 125-kw capacity, consisting of two boilers and two generating units of 75 and 40 kilowatts, respectively. The cost of this plant would be $10,000, depreciation at 10 per cent, $1,000 per year, and interest $600 per year. It would require two men and an engineer, at $1,000, and a fireman at $600 per year. As better evaporation could be secured with a plant so arranged than in a plant with a single boiler, he figured an evaporation of 7 pounds of water per pound of coal, which with the same output as before amounted to $1,712 for coal bill for the year. Figuring in all items, the cost of power would be $4,559 per year, of $0.0285 per kw-hour, deducting the cost of direct steam heating as before.

One other type of isolated plant considered was the small gas engine plant. He figured on one having a continuous load of 20 hp, making an output, if operated 10 hours per day for 300 days in a year, of 60,000 hp-hours. He found the lowest guarantee made by gas engine manufacturers to be 14 cubic feet of gas per brake hp-hour, using Chicago gas. At $0.50 per 1,000 cubic feet, this would make the cost $420 per year. The labor he figured in with the janitor service of the building and made no charge against the isolated plant. Supplies were estimated at $0.50 a day, or $150 a year. Cooling water required would be only about $3 a year. Estimating the cost of such a plant to be $3,500, depreciation would be $350 at 10 per cent., and interest $210, making the total cost $1,133 per year, $0.019 per hp-hour, or $0.0332 per kw-hour.

Mr. S. M. Bushnell, of the Chicago Edison Company, then read a very carefully prepared argument in favor of the central station as against isolated plant supply of current. By way of introduction he stated that the central station was an outgrowth of the present-day conditions, and that the tendency of the times was towards concentration and consolidation. This is an age of combination. The central station is but one example of this. In order not to make the discussion too general to be of any value, he confined his remarks to a few Chicago conditions. Here, he stated, that two companies allied to each other, the Chicago Edison Company and the Commonwealth Electric Company had acquired all the small inefficient central stations in the city, and by consolidating into large generating plants were able to materially reduce the cost of operation. The policy of these two companies was to reduce the cost to the consumer to the lowest possible figure consistent with a fair return on the actual money invested, and stability of business and permancy of investment were sought rather than extraordinary profits.

These companies had paid interest at 6.47 per cent. on the actual investment for some time. The present investment is $16,598,000. The franchises under which they operate allow a charge of $0.20 per kw-hour. Eight years ago a sliding scale was adopted for power, with 10 cents per kw-hour as maximum, and as further adjustment of rates seemed to be necessary a department was started in the company which devotes its entire time to an analysis of the cost of producing and distributing electrical energy, in order to arrive at the proper rates for all conditions. The old rates, while providing for the actual consumption of current neglected the question of idle investment necessary in order to be prepared to furnish certain classes of customers. A new system of charging was, therefore, begun, based on the Wright maximum demand meter. By this the continuous user of light or power who has a low maximum load obtains the best rate, since the investment required to supply him is lowest in proportion to the amount of energy he consumes.

By this system, with the present scales, the cost to customers for power is from $0.04 to $0.15 per kw-hour. As showing that consumers are as a matter of fact finding it profitable to abandon isolated plants in favor of central station supply, Mr. Bushnell referred to some statistics taken from Chicago. Thirty consumers have, in the past year, abandoned isolated plants to get central station supply. According to the city elcctrician's report, there was a net decrease of an equivalent of 50,000 16-cp incandescent lamps on isolated plants as compared to central station service in 1901. Among the reasons tending to make it possible for central stations to give service

cheaper than isolated plants may be mentioned, that the average load on the central station, owing to the great number of its consumers, is more nearly steady, and hence its load factor is better than an isolated plant; then, too, the central station has both down-town and residence districts to supply, and when the down-town district is quiet after business hours the same generating equipment is supplying current to outlying residence districts. The coal consumption of a large generating station, such as that of the Chicago Edison Company, is about one-third of that of an isolated plant per kw-hour; the large plant also has all the advantages of labor-saving appliances in coal and ash handling and the small attendnce per kw of output required for very large engines. For convenience, he classified those customers likely to consider isolated plants versus central station supply under six heads.

1. Churches and public halls, if supplied from an isolated plant, would require a large investment in proportion to the actual quantity of energy used in lighting. This investment would lie idle a greater portion of the time, hence the advisability of a supply from central station in this case is apparent. Freedom from noise and the vibration of an isolated plant is important in a church or public building, as is also availability at all hours without special preparation, and in these places space is often valuable.

2. Office buildings and apartment house owners object to the isolated plant principally on the ground of the annoyance of taking care of such a plant and of having it in the building and the friction which arises in the supplying of current to tenants. As far as the owners of these buildings are concerned, it is more convenient and agreeable to them to let tenants purchase of central stations than to attempt lighting themselves and maintain the plant.

3. Retail stores have a good load factor, and hence in this respect conditions are favorable for the isolated plant. However, the Wright demand system of charging makes possible a very low rate for central station supply to this class of customers. Space is so valuable in many retail stores at present that it can be ill spared for a plant. The question of reliability is also to be considered. The space available for coal storage in a retail store is very small, and the plant is liable to interruptions on account of the blockades and strikes shutting off the coal supply or by the breakage of water mains. Central stations supply is more to be depended on. The use of electric elevators in these stores make possible the supply of all power from the central station mains, leaving only the heating plant in the store.

4. In wholesale houses the extensive use of electric elevators gives an extremely variable load for an isolated plant, and in such a case central station supply is more desirable.

5. Newspaper and printing offices desire, above all else, absolute reliability that nothing may delay publication. This reliability can better be secured from central station than from isolated plant service, as previously explained. The three-wire system of direct current supply from the Edison mains offers a handy means of getting two speeds on a printing press motor.

6. Hotels and restaurants. In this the question of valuable basement room is one of the most important factors in deciding in favor of central station supply.

In conclusion, Mr. Bushnell said that while it was difficult to secure the adoption of central station supply where isolated plants had been already installed, it became an easier matter when the isolated plant was worn out. While it had been at some times considered that the development of the isolated plant was in the interest of the electrical manufacturer and consulting engineer, he felt that the central station was the best ally to the consulting engineer and the electrical business because of the stimulating effect it had on the use of electrical apparatus and electrical power transmission in large and small factories and shops.

Mr. Charles F. Hart, chief engineer of the Chicago *Record-Herald*, said that it was a difficult matter to get an honest discussion on the question of isolated plant versus the central station, because everyone sufficiently interested to discuss it was prejudiced by his pocketbook one way or the other. The central station men were, of course, in favor of that kind of supply, while the consulting engineers and the chief engineers of large isolated plants and the manufacturers of small electrical apparatus would naturally be in favor of isolated plants because it meant money in their pockets. He thought there never would be a disinterested discussion of the question. For his part, he could not discuss it honestly, and he did not believe anybody else could. He said if any Edison Company employe could be found who had given a customer a receipted bill for power and light at a rate of $0.04 per kw-hour, that man would lose his job immediately. (Laughter.) That $0.04 rate, mentioned by Mr. Bushnell, looked very well but applied only to power, and when one came to pay for light at $0.08 per kw-hour, central station figures did not come so near isolated plant figures as Mr. Bushnell had made them appear.

He admitted, as is true, that the large generating stations could evaporate water cheaply, but the loss between switchboard and consumer amounted to 50 per cent. He did not believe it possible for a central station company with its distribution losses and other carrying charges to deliver current as cheaply as the isolated plant could furnish it. A great deal had been said about the importance of the electric elevator in a consideration of this problem. From his observation the electric elevator had not been a howling success in more than six large stores in Chicago. One feature of central station supply, which he thought might be more fully emphasized, and which, as chief engineer of a newspaper plant, he appreciated very much, was the function of a central station supply as an insurance against interruption. He got a great deal of satisfaction out of the throw-over switch which enables his concern to be supplied from the Edison mains at any time his isolated plant may fail. He had never used it, but he was very glad to have it there, and thought that as an insurance company the central station company was very valuable, and that a charge might legitimately be made for this insurance feature, even if the central station supply was never used.

Mr. Scheible questioned the statement that the losses in distribution amounted to 50 per cent.; he thought they came nearer 25 per cent.

Professor Woodworth, chairman of the meeting, skilfully analyzed the discussion and made it clear that there were certain conditions under which it was unquestionably better to put in an isolated plant, and there were certain other conditions where central station supply was unquestionably the best, the latter being in the case of small users. The discussion hinged, he said, over the great middle ground where there was some question between the two methods. Each case must be considered by itself. He mentioned the solution of the problem that he had decided upon at the Lewis Institute plant. For a portion of the year, when the load is heavy and much steam heat is required, the isolated plant was run; for the balance of the year, when no steam heat was used and the load was light, the central station current was taken. In this way the high maximum demand charges of the central station were avoided and the high operating costs of running an isolated plant very much underloaded were also avoided.

Mr. John Mabbs, chief engineer of the Board of Trade, said that a few years ago his employers were confronted with the necessity of either installing an entirely new plant in the building or arranging for central station supply. The matter had been gone into very thoroughly by competent engineers, and the result of the decision was that $50,000 was invested in an isolated plant for the Board of Trade Building. The cost of power at the Board of Trade is now one-half what it would be with central station supply. They practically had heat free for seven months of the year. The maximum capacity of this plant is 250 kw, but the demand rarely reaches over 150 kw. Current is sold by meter to the tenants of the building on the basis of $0.10 per kw-hour, with a sliding scale which gives a customer of 1,000 kw-hours per month a rate of $0.05 per kw-hour.

Mr. Peter Junkersfeld thought that the figures given by Mr. Dresser at the beginning of the discussion assumed too high a load factor, and that the actual average load of most isolated plants would be lower in proportion to the machinery installed than under his assumption. He also thought that the $100 per year estimated for rent and insurance was entirely too low, and that the space occupied by the isolated plant would rent for much more than that amount. Such a plant would require 15 to 20 sq. ft. per kw of capacity. The Chicago Edison Company, with large consumers having a high load factor, made a rate which came within 3 per cent. of the $0.0285 per kw-hour figured by Mr. Dresser. He cited the increase in the number of central station customers taken from isolated plants as taken from the Chicago city report, and said that it was unlikely that all these new customers which had taken central station service had not gone into the matter very thoroughly, and the fact that they had decided in favor of central station supply went far towards proving the central station side of the case.

Mr. George D. Van Tassel, chief engineer of the Anglo-American Provision Company, thought that if the same grade of talent was

employed to supervise isolated plants and to convince owners as to their economy as is employed by central station companies in convincing owners of the economy of central station supply, there would be more isolated plants than there are.

In regard to the isolated plants in large office buildings, Mr. Hart made the point that where hydraulic elevators were used the exhaust steam from them is sufficient for most of the heating, and that this argument in favor of the isolated plant was not very strong.

These are but the main points of the discussion, which was extended and lively, but at all times good natured. The evident impossibility of getting unbiased testimony as to the cost of central station or isolated plant supply, caused considerable amusement at times, and was realized by none better than by the speakers themselves.

Recent Developments in Electrochemistry.

BY CLINTON PAUL TOWNSEND.

Electrochemistry is fairly represented in the great patent issue of April 29th—an issue comprising seven hundred mechanical patents, and far surpassing all previous records of the office.

ELECTROLYTIC PREPARATION OF PARIS-GREEN.

Mr. Richard Franchot, of Niagara Falls, proposes the following interesting and simple method for the preparation on a commercial scale of paris-green, the aceto-arsenite of copper. A copper anode is dissolved in a mixed solution of calcium acetate and arsenious acid, whereupon the separation of the insoluble double salt occurs directly. The reaction is strictly anodic, and in order to maintain the separation of the cathode products, the cathode, a sheet of copper, is enclosed in a linen bag which performs the function of a diaphragm. It is essential that this separation be complete, since either the hydrate or the hydrogen formed at the cathode would destroy the regular course of the reaction, the former by the precipitation of the corresponding copper compound, and the latter by the reduction of arsenious oxid with liberation of the highly poisonous gas, arsine.

Prior investigators have not, it would seem, touched upon this field, though Mr. Franchot's work recalls the method whereby Scheele's green has been produced by the electrolysis of an eight per cent. solution of sodium sulfate with copper electrodes in the presence of suspended arsenious oxid; in this case the copper is dissolved as a sulfate and the arsenic as sodium arsenite, an interchange resulting in the precipitation of copper arsenite and the regeneration of the sodium sulfate. Mitis green has also been produced in an analogous manner, the arsenious oxid being replaced by a solution of the pentoxid which trickles slowly into the bath around the cathode.

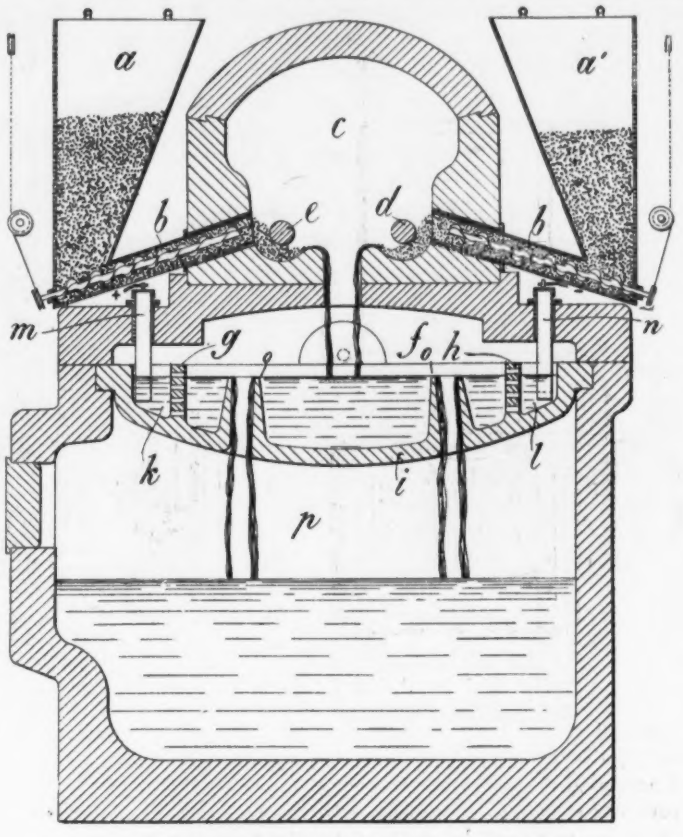
ELECTROLYTIC TREATMENT OF TIN-SCRAP.

A somewhat vague description of a method for the electrolytic recovery of tin from scrap metal occurs in the specification of Ernest Quintaine, of Argenteuil, France. The essential feature seems to be the composition of the bath, which is formed by gradually adding ammonium chloride and a chloride of tin to an acid solution of the nitrate of the latter metal, the addition being continued until the bath becomes clear. With a scrap tin anode, a lead cathode, and a very weak current, the tin is dissolved and redeposited in the usual spongy form upon the cathode.

GLASS MAKING IN THE ELECTRIC FURNACE.

Two patents to German inventors represent progress in the utilization of the electric current for the manufacture of glass. This is one of the most promising of the newer applications, and is of particular interest because glass at a sufficient temperature becomes a conductor of the second class; in other words, an electrolyte, and these later methods for its treatment represent to some extent developments of the Nernst principle.

August Voelker, of Ehrenfeld, in the device herewith diagramatically shown, both melts the raw material and refines the glass, applying to the former operation the arc and to the latter the resistance principle. The electric furnace-chamber *c*, of Chamotte, surmounted by the reflecting dome, carries electrodes *d*, *e*, beneath which the raw material is fed from hoppers *a*, *a*¹, by screws *b*. The molten mass overflows into the refining pot *f*, likewise of Chamotte, and constructed with integral perforated partitions *g*, *h*. Into the lateral chambers *k*, *l*, formed by these partitions, dip carbon electrodes *m*, *n*, between which the circuit is closed by the molten glass. Under the influence of the heat developed the glass becomes fluid and is rapidly cleared from gas bubbles, while the perforated partitions prevent its contamination by fragments from the electrodes. With reference to the current used, this astonishing statement is made: "It may,



APPARATUS FOR MANUFACTURE OF GLASS.

however, be assumed that five amperes for each square millimeter of electrode-surface is a fair maximum."

Johann Lühne, of Aachen, describes a rather complicated structure operating on analogous principles. The raw material is melted by passing through a series of arcs, developed between a horizontal prismatic bar of carbon, and a series of horizontal electrodes ranged along either side. The central bar is hollow and laterally perforated for the injection of hydrogen to raise the temperature of the belt of arcs. The raw material thus fused flows through a run-way in the base of which are imbedded any of the usual Nernst conductors, by the heat of which it is brought into a highly fluid state before it is discharged into the refining pots. This furnace is said to be applicable to the highest grades of optical glass, colorless and absolutely uniform in structure.

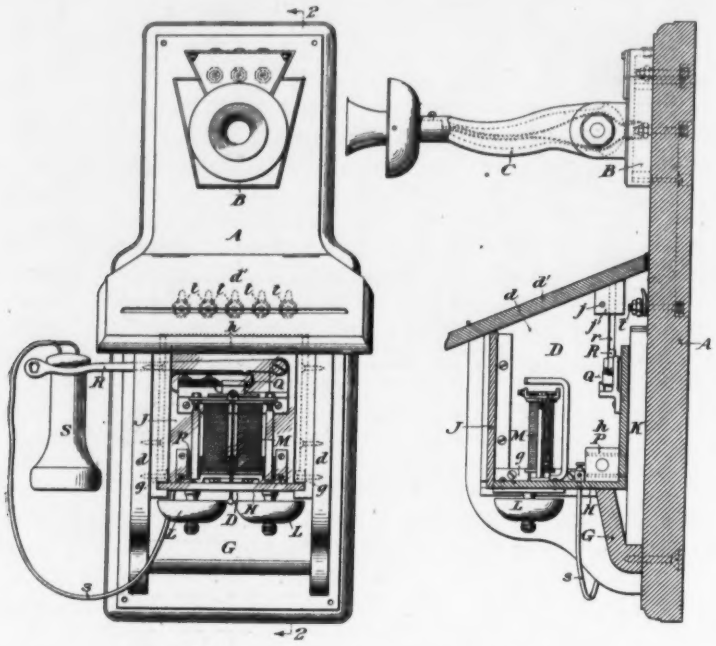
Since this particular art is so little developed, it may be of interest to refer briefly to the work done therein by prior inventors. S. Reich & Company patented in Germany, in 1882, a resistance furnace comprising substantially an open-bottomed crucible, of a carbon composition, into which the raw material was fed, being retained therein by a net of platinum wire; heat developed in the walls of the crucible fused the material into glass which dripped directly into the refining pots. More recently, Becker & Co., of Paris, have patented a number of forms of furnace, in all of which the raw material passes successively under or through a series of arcs, being thereby melted. Reference may be made also to the work of Sudre and Thierry, of Paris, who have been producing for industrial purposes compounds of refractory oxids in the electric furnace; while not strictly glass, in the ordinary acceptance of the term, these products are vitreous, transparent and homogenous, and far more refractory than ordinary glass.

Wireless Telegraphy to the North Pole.

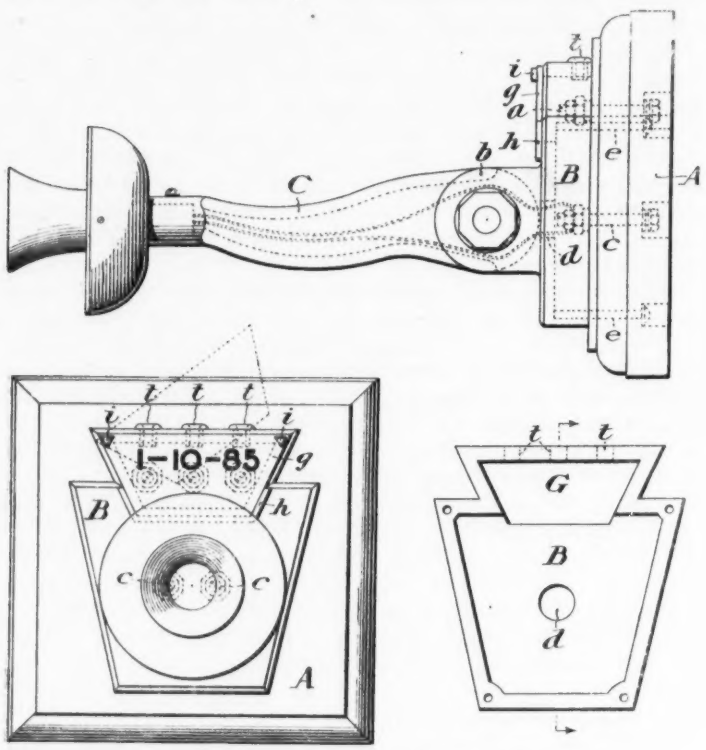
It is stated that Capt. Bernier, the Arctic explorer, who will head the Canadian expedition to the North Pole, will take with him wireless telegraph instruments, by means of which he will endeavor to keep the world informed as to his progress. Capt. Bernier states that he has arranged with the Marconi Company for the instruments, and will take with him an engine and dynamo plant.

New Telephone Patents.

After a burst of activity resulting in the issue of a dozen or so patents relating to telephony, the issue of April 29th yields but a couple of inventions, both relating to details of telephone sets. Mr. Charles E. Wilson, of Philadelphia, is the inventor of both these devices and assigns them both to the Keystone Telephone Company, of that city. The first patent is on a telephonic wall set, in which all the working parts except the transmitter are mounted on a base-plate, so that the whole organization may easily be withdrawn for repairs or renewals. This is to enable the inspector to substitute a duplicate set, in the event of difficult repairs being necessary, without removing the whole instrument, and the arrangement



FIGS. 1 AND 2.—WILSON WALL SET.



FIGS. 3 AND 4.—BASE PLATE FOR TRANSMITTER ARMS.

also makes the parts more accessible for ordinary repairs. Referring to Figs. 1 and 2, *D* is the bell-box, having sides *d d* fixed to the backboard *A*, and top d^1 hinged to *A* in the ordinary manner. At the bottom of the box is the inclined tray or trough *G*, which supports the condenser *K*. On the inside of each side *d* of the box is a grooved trip *g*, in which slides the metal plate *H*, forming the bottom of the box; *H* is turned up at the back, forming a bracket *h*. The glass plate *J*, sliding in vertical grooves, forms the front of the box, overlapping *H* and held in place by the lid d^1. The lid is locked by a screw *j* passing through the side of the box and engaging in a lug j^1 on the under side of d^1. This screw *j* has a triangular head so that the box can be unlocked only by a special key carried by the inspector. The various parts of the mechanism are fixed to the plate *H* or its rear extension or bracket *h*, so that by opening the lid d^1, lifting the receiver hook out of its slot and sliding up the glass plate *J* the entire set of instruments can be withdrawn from the box for inspection or repairs. The connections are made by the binding posts *t t*. This is a neat and effective arrangement of the mechanism of a telephone set and ought to be of considerable help toward good maintenance.

Mr. Wilson's second patent is on a base-plate for transmitter-arms, the object of which is to provide a concealed cavity for the line-terminals to prevent the public from tampering with them, while the covering of the recess is of such construction as to be readily accessible to the telephone employes. As shown in the drawings, Mr. Wilson makes his base-plate in the form of a keystone, which is patriotic, affords an attractive design, and especially lends itself to the effectual concealment of the aperture by which access is to be had to the terminal binding posts. The plate is a hollow casting, affixed to the back-board *A*; *a a a* are the binding posts, the wires entering by the apertures *t t t*, the wiring from the posts to the different parts of the instrument being done in the regulation manner. Covering the aperture *G* in the base-plate over the binding posts is a metal plate *g*, of similar shape, which is used to carry the number card. This is attached by screws *i i*, having triangular heads so that they can only be unscrewed by a special key. By unscrewing one screw and using the other as a pivot the cover or card can be revolved away, uncovering the aperture and revealing the binding posts. Several alternative methods are suggested of affixing the card plate used as a cover. This strikes one as a neat little improvement in the construction of exchange transmitters.

San Antonio Meeting of the Southwestern Gas, Electric and Street Railway Association.

At the meeting of the Southwesten Gas, Electric and Street Railway Association, held at San Antonio last month, Mr. E. H. Jenkins, of San Antonio, Tex., was elected president; Thos. D. Miller, of Dallas, treasurer, and H. A. Evans, of San Antonio, secretary. Other officers were elected as follows: Vice-president, C. F. Yaeger, of La Rede, Tex.; E. Dysterud, of Monterey, Mex., and A. E. Judge, of Tyler, Tex. Directors: H. F. MacGregor, of Houston, Tex.; Thos. D. Miller, of Dallas, Tex.; T. H. Steuart, of Waco, Tex.; S. A. Spencer, of Jennings, La.; H. T. Edgar, of El Paso, Tex.; W. A. Guthrie, of San Antonio, Tex., and J. R. Ward, of Beaumont, Tex. Dallas, Tex., was selected as the next place of meeting.

In a paper, entitled "The Flat-Rate Nuisance," Mr. Thos. D. Miller, of Dallas, Tex., attacked the flat-rate system of charging, setting forth the usual arguments against this system and in favor of the meter system. He considers that any electric light plant doing an exclusive flat-rate business could furnish on the meter basis current to from 25 to 75 per cent. more lamps at the same cost for operating expenses, or have the gross receipts proportionately increased by quoting a fair price for the service rendered to each customer, and no more than a fair price from anyone. Many electric light companies have gotten on a paying basis by an introduction of the meter system.

Mr. W. E. Judge read a paper on "How to Increase the Income," in which he advocated efficient methods of watching, testing, recording, accounting and canvassing. He considers that the method of charging on the Wright demand system would lead to very satisfactory results.

National Contractors.

The National Electrical Contractors' Association of the United States will be held at Philadelphia, July 13 and 14. Mr. W. Morton, of Utica, is secretary.

A Degree to Lord Kelvin.

At New Haven, Conn., on May 5, Lord Kelvin received from Yale University the honorary Degree of Doctor of Laws. The ceremony took place in Battell Chapel. It was the first time in over 100 years that a special assembly has been held at Yale for the conferring of an honorary degree. The distinguished scientist was ushered into the church by President Arthur T. Hadley, to the strains of music by a great symphony orchestra, followed by the most eminent members of the university corporation and faculties. The ceremonies were short. After the preliminaries Lord Kelvin was presented for the degree by Prof. Russell Henry Chittenden, Ph. D., Director of the Sheffield Scientific School. President Hadley conferred the degree, and said: "You have joined the different regions of the earth by your investigations of the submarine telegraph; you have joined the different realms of human thought by your contributions to physical theory. We confer upon you the degree of Doctor of Laws and admit you to all its rights and privileges." As the hood of the degree was slipped over the shoulders of the eminent scholar there was great applause. Lord Kelvin responded with thanks for the honor conferred, and after a tribute to Yale, reviewed briefly the development of the teaching of science in universities.

Lord Kelvin has been putting in a busy week on his return to New York City on Tuesday. The morning of that day he visited the laboratory of Mr. Peter Cooper Hewitt to see his mercury vapor lamps. After that he visited the Westinghouse lamp factory on Twenty-third Street with Mr. C. A. Terry and Mr. C. W. Rice, second vice-president of the Nernst Lamp Company. Late in the afternoon, escorted by President Cutler and Chief Engineer Carty, of the New York Telephone Company, Lord and Lady Kelvin inspected the new Cortlandt Street exchange, talked over the line to Chicago, and saw some of the Pupin "distributed inductances." They were received by President Fish and Vice-President Hall, of the American Telephone and Telegraph Company; President Clowry and Vice-President Clark, of the Western Union Telegraph Company, and by Messrs. Bethell, Sargent, Reilly, Wilson, Cahill, Webb, Thurber, Renouard, Schultz, and others of the telephone service of Greater New York; Mr. Thayer, of the Western Electric Company, and others. About an hour was spent at the exchange. On Thursday, Lord Kelvin was scheduled to visit the big Edison Riverside station, and to dine with Mr. Anthony N. Brady and officers of the New York Edison Company, at Delmonico's, to meet the leaders of the electrical industry in New York. On Friday Lord Kelvin is to visit Mr. Edison at the Orange laboratory, and on Saturday he sails for England.

CURRENT NEWS AND NOTES.

THE ST. LOUIS WORLD'S FAIR will, it is now determined, be put off for one year, as it is evident that it could not be ready by 1903.

THE CINCINNATI CONVENTION.—It appears that in connection with the approaching convention of the National Electric Light Association, at Cincinnati, a number of eastern delegates propose to leave on the preceding Sunday, over the lines of the Pennsylvania system. The Chesapeake & Ohio Company has also an excellent service for reaching the convention city, and has the well-known "F. F. V." Limited, which, leaving New York at 5 P. M. daily, reaches Cincinnati just 24 hours later. This is a solid, vestibuled train, lighted by electricity, with through dining car service, observation cars, and a most picturesque route. It seems likely that many will avail themselves of this train on Sunday evening, May 18, and, if necessary, extra sleeping cars will be added. Reservations of space should be made immediately in accordance with the announcement in our pages elsewhere.

CAP AND GOWN.—A telegram from Ithaca, N. Y., of May 3, says: The action of President Jacob Gould Schurman yesterday in introducing Lord Kelvin, attired in cap and gown, is causing no end of comment among Cornell professors, and it is thought that it means that Cornell will break away from the old traditions and will adopt the academic garb on all university occasions. The gown in question was procured in April while President Schurman was in Scotland, and was worn by him when he received the degree of LL. D. from the University of Edinburgh. It is a gorgeous affair, and will be worn by him at the important exercises hereafter. Hitherto there has been a strong feeling against this academic insignia and many professors are now pronounced in their opposition, but it is thought that the Faculty at its next meeting will follow the precedent set by the president.

OBSCURANTISM IN ELECTRO-CHEMICAL INDUSTRY.—In a discussion of a paper by Rhodin on "The Electrical Manufacture of Caustic Soda and Bleaching Powder," at Sault Ste. Marie, Ont., before the Canadian section of the (British) Society of Chemical Industry, it was reported that the hearty support which the manufacturers had given to the American Electrochemical Society, indicated that the policy of obscurantism in the electro-chemical industry was about to be abandoned. This also shows that such a society was needed to bring out papers from the industrial interests, and that those who are at the head of these industries probably appreciate the fact that their gain is probably greater than any supposed loss. A short time after the recent meeting of that society, at which an inventor of a process called attention to difficulties which he was having, he was enabled to improve his process very greatly, and admitted frankly that he was led to this improvement by the discussion which took place when he described before the society the difficulties which he had encountered. This is a good illustration of the great gain to the industries due to the frank discussion of their processes.

EFFECT OF LIGHTNING DISCHARGE ON BIRDS.—Mr. Leonard Joseph, in a communication to the British Institution of Electrical Engineers, reports that on Dec. 9, of last year, during a heavy storm, accompanied by thunder and lightning, a wild goose fell through the air and with a thud buried itself fairly deep in the sand. On the abatement of the storm, at a distance of approximately a kilometer from the point at which the bird above referred to was picked up, another dead wild goose was found. On a careful examination of the two birds, it was found that the only wounds upon them were " a narrow but direct opening about 3 cm long" on the back of the neck of the first found bird, and a small puncture "at a point where the neck joins the body" on the second bird. Excepting in the immediate neighborhood of these wounds the bodies and feathers of the birds were uninjured. The feathers at these points appeared and smelt singed. Both birds proved perfectly fit for the table. During the storm five flashes of lightning only were observed. Judged by the position in which the birds were found, Mr. Joseph is of opinion their flight was in opposite directions, the wounds in each instance being instantaneously fatal.

MR. YERKES IN LONDON.—A special cable dispatch from London, of May 3, has the following: There have been some interesting developments in the battle between the American millionaires for control of London's rapid transit system. One feature that stands out more than any other is Charles T. Yerkes's ability to beat English lawyers at their own game. Counsel for the Morgans' projected "tube" line had Mr. Yerkes on the stand before the House of Lords Committee for an hour or so one day this week. Mr. Yerkes sat passive, ingenuously answering or dodging questions relating to the financial plans of his own syndicate. Finally he calmly remarked to counsel: "I have been listening to your explanations of this matter," at which counsel hurriedly corrected the witness by declaring he had only been asking questions. But Mr. Yerkes, imperturbable and hugely amusing the committee, continued: "And it seems to me that you have certain information which I myself do not at this moment possess." With a smile, Mr. Yerkes next admitted that he was largely interested in the financial and operating departments of the new road, but, without a trace of apparent malice, he added: "I do not care to teach kindergarten schools here." The Morgans had questioned the correctness of the figures upon which Mr. Yerkes based the returns of his system, and Mr. Yerkes blandly waved aside such details, saying that he had not his notes, but would be delighted to solve the sums in arithmetic submitted to him by opposing counsel if they would allow him to bring notes referring to such abstruse matters from his office. Finally the Chicagoan was dismissed somewhat disgustedly, with the remark: "As you do not want to be sent back to school, I will not ask you any more questions," and Mr. Yerkes went out, smiling grimly.

A "SIMIAN" UNIVERSITY.—The Boston *Transcript*, in an article on some experiments on wireless telegraphy by a local electrician, says that "As near as can be determined the system is based on the principle brought out by Dr. Hertz, professor of physics, in a large Simian university, in 1888."

OHIO ELECTRICAL CONVENTION.—The Ohio Society of Mechanical, Electrical and Steam Engineers will hold its convention at Mansfield, on May 10. The wide scope of the society's activities promises a meeting of much interest to its members. Papers of interest to all three branches of engineering will be read and discussed.

NEW MEMBERS OF THE INSTITUTE.—At the meeting of the directors of the Am. Inst. of Electrical Engineers, held April 25, the following associates were elected: Anderson, Edward H., designing engineer, General Electric Company, Schenectady, N. Y.; Anthony, James Stowell, General Electric Company, 44 Broad Street, New York City; Badeau, Charles Cushing, switchboard engineer, Wagner Electric Manufacturing Company, St. Louis, Mo.; Bailey, Theo. P., assistant manager, Chicago office, General Electric Company, 1047 Monadnock Building, Chicago, Ill.; Brisley, Edward Betts, student, Stevens Institute, Hoboken, N. J.; Clark, Wallace S., engineer, wire, cable and tube department, General Electric Company, Schenectady, N. Y.; Cole, William Weeden, vice-president and general manager, Elmira Water, Light and R. R. Co., Elmira, N. Y.; Cutler, James Elmer, manager Philadelphia office, Stanley Electric Manufacturing Company; Edmondston, Edgar Davis, electrical engineer, The Lackawanna Iron and Steel Company, 401 Delaware Avenue, Buffalo, N. Y.; Ekstrand, Charles, superintending engineer, Brooklyn Cooperage Company, Brooklyn, N. Y.; Ellinger, Edgar, electrical engineer, George A. Fuller Company, New York City; Gray, Clyde D., assistant in electrical department, J. G. White & Co., 29 Broadway, New York City; Hellebuck, Gustave J., electrical engineer, Mediterranean Thomson-Houston Company, 5 Piazza Castello, Milan, Italy; Hines, Charles Henry, superintendent electrical department, Lorain Steel Company, Lorain, Ohio; Holman, George Ulysses Grant, general manager, The Canadian Electric Light Company, Limited, 12 Laporte Street, Quebec, P. Q.; Hough, Benjamin Kent, sales engineer, Stanley Electric Manufacturing Company, 1601 Empire Building, New York City; Humphrey, Calvin B., office manager, Westinghouse Electric and Manufacturing Company, 711 Neave Building, Cincinnati, Ohio; Hunt, Charles Wallace, president, C. W. Hunt Company, Stapleton, N. Y.; Judson, Hanford Chase, assistant engineer, General Electric Company, Dobbs Ferry, N. Y.; Leblanc, Maurice, consulting electrical engineer, Westinghouse Electric and Manufacturing Company, Villa Montmorency, Paris, France; McNary, Charles Herbert, superintendent of Provo Station, Telluride Power Company, Provo, residence, Nunn's, Utah; Miles, J. Walter, electrical engineer, Westinghouse Electric and Manufacturing Company, Irwin, Pa.; Miller, Dwight Dana, salesman, Westinghouse Electric and Manufacturing Company, 120 Broadway, New York City; Murphy, George R., engineer, operating department, The Electric Storage Battery Company, New York City; O'Donovan, Leo J., student, Columbia University, 302 West Seventy-second Street, New York City; Sheldon, Edward Ellis, electrical engineer, Hudson River State Hospital, Poughkeepsie, N. Y.; Short, Sidney Howe, technical director, The English Electric Manufacturing Company, 112 Cannon Street, London, E. C., England; Stoker, Simon Brewster, engineer, Westinghouse Electric and Manufacturing Company, Syracuse, N. Y.; Stovel, Russell Wellesley, electrical engineer, Pittsburg and Lake Erie Railway, Coraopolis, Pa.; Waddell, Charles Edward, electrician in charge electrical department, Biltmore Estate, Biltimore, N. C., Wellman, Harold Robinson, electrical engineer, motor department, General Incandescent Arc Light Company, 572 First Avenue, New York City; West, Erastus Lovette, assistant to electrical engineer, J. G. White Company, 29 Broadway, New York City; White, Francis Joseph, student, Columbia University, 53 St. John's Place, Brooklyn, N. Y.; Wilson, Norman James, electrical engineer, British Westinghouse Electric and Manufacturing Company, Limited, Trafford Park Works, Manchester, England; Woodbury, Daniel Coryton, student, Stevens Institute of Technology, Hoboken, N. J.; Yorke, George Marshall, assistant electrician, American Telephone and Telegraph Company, 15 Dey Street, New York City.

LETTERS TO THE EDITORS.

The Wright Demand System.

To the Editors of Electrical World and Engineer:

Sirs.—In your editorial of April 26th, on the system of charging customers at Woburn, you say, "If the capacity or investment charge were carried to its legitimate conclusion the price to certain classes of customers would become quite prohibitive—a condition which the authorities would not tolerate."

I am interested in the system of charging used at Woburn, because it is on exactly the same principles as those which form the basis of the Wright demand system, the only difference being that at Woburn they use (or rather propose to use if they can make one) an instrument which limits the maximum demand, instead of the Wright indicator, which merely measures the maximum demand.

In regard to the paragraph in your editorial quoted above, I disagree entirely. In the first place, the fact that the price of electricity is prohibitive to certain classes of customers is no ground for the authorities to interfere. The price of electricity for heating is prohibitive in almost all cases. It is prohibitive to the large majority of the class of small customers who use kerosene light. It is prohibitive to any customer who is at a distance from a central station. In fact, since less electricity is used than gas and kerosene, etc., it is safe to say that the price of electricity is to-day prohibitive in the majority of cases.

The Wright demand system, including the modification of it used at Woburn, and referred to in your editorial, is based on the principle that the charges to each customer should be based on the cost of supplying such a customer. If carrying this principle to its legitimate conclusion makes the price prohibitive to such a customer, it follows that that customer belongs in that large class who (at present costs of production of electricity) cannot afford to use it. The authorities would not interfere to require the central station to supply such a customer at a loss, since the central station would have to recoup itself for this loss by charging its other customers too much. The authorities would rather interfere to forbid supplying such a customer at a loss.

You yourself, on the same page, refer to such a case as occurring at Waltham, where the electric lighting company had been supplying current at a loss to a particular customer, and, so far from prohibiting the raise of price, the commissioners in effect required the company either to raise the price to this customer or to stop supplying him.

Of course, in practice rates must be adjusted to local conditions to a certain extent, and it would be easy to carry the principle of the investment charge to an extreme. Take the case, for instance, of a circus visiting a town for one night only. It would not be right to charge the circus the whole first cost of the engines and dynamos necessary to supply it with light, as well as the cost of the coal and labor.

Possibly I am overhasty in criticism, and you refer in your editorial to cases similar to the circus. The point I want to bring out is one which your editorial does not leave clear, and that is that no company should or can be required to supply a customer at a loss, and that the Wright system, even as used at Woburn, without the Wright indicator, comes nearer this ideal than any other possible system, except the Wright system with the Wright indicator.

BOSTON, MASS. R. S. HALE.

Synchronous Reactance.

To the Editors of Electrical World and Engineer:

Sirs.—Mr. F. G. Baum's article on "Synchronous Reactance," in your issue of April 26th, recalls to my mind the warfare I waged for years in the electrical papers against too strict a belief in the applicability of the short-circuit current for determining the potential drop in alternators.

When, in 1894, Dr. Behn Eschenburg, of Oerlikon, suggested the use of the short-circuit current for the purpose of calculating the synchronous reactance, this idea marked a great step in advance in the rational calculation of alternating current machines. While correct within the range of proportionality between magnetizing force and induction, it was only very approximately correct for high saturations. Time and again I pointed out this fact, backing up my argument by a series of experimental investigations. I will here re-

fer only to my letters on this subject in 1896 in *Elektrotechnische Zeitschrift*, Berlin, and to my papers on "The Factors which Determine the Design of Single-phase and Multi-phase Alternators," ELECTRICAL WORLD AND ENGINEER, 1900, Jan. 20, 27 and Feb. 3, where I showed that in alternators in which the field and armature leakage had been made small, the drop is considerably smaller at higher saturations than would follow from the synchronous reactance calculated from the short-circuit curve.

The regulation curves of Fig. 1 in my article in the Berlin paper, 1899, number 48, very strikingly illustrate the error introduced by using the short-circuit curve, and I particularly refer Mr. Baum to this paper for a critical estimate of the method.

Prof. Alexandre Potier bases on these experiments of mine his method of predetermining the drop in alternators. I must refer to his paper, "Sur la réaction d'induit des alternateurs," in *L'Eclairage Electrique*, 1900, p. 133, where he elaborates a very useful method identical with Mr. Baum's, given in your issue of April 26, 1902; and while I am in agreement with Mr. Baum's paper, I cannot forbear from remarking that it seems surprising that at this late season novelty can be claimed by Mr. Baum for discovering the discrepancy between calculation and observation in using the short-curcit current for determining the drop in alternators. So far as proposing a method is concerned for avoiding the error above alluded to, the credit is due to Prof. Alexandre Potier, whose paper was duly given in extract in the Digest of the ELECTRICAL WORLD AND ENGINEER.

CINCINNATI, OHIO. B. A. BEHREND.

DIGEST
OF
CURRENT ELECTRICAL LITERATURE.

DYNAMOS, MOTORS AND TRANSFORMERS.

Direct-Current Armatures Supplied with Alternating Current.—FLEISCHMANN AND ORGLER.—A well illustrated article referring to Latour's paper (noticed before in the Digest) on the properties of ring armatures which are supplied with single or polyphase currents through the commutator by means of stationary brushes. They give a simple explanation of the processes in such armatures. They first consider a ring armature which receives single-phase alternating current from two diametrically opposite brushes, the armature being fixed and the brushes revolving synchronously (*i. e.*, with the same speed as the vector of the current). They show that the e. m. f. induced in the windings, and, therefore, also the reactance of the ring, is entirely independent of the speed of rotation of the brushes. The magnetic flux varies at all points of the ring with the double frequency of the applied alternating current, the flux waves being pulsating waves; the variation of the flux all over the armature during a complete period is given in a series of diagrams. They then consider the same ring armature when it is supplied with two-phase alternating currents through two pairs of brushes, displaced in space by 90 degrees. When the brushes rotate synchronously, the flux has a constant value at each point of the ring, and the reactance of the ring is zero. If the brushes are fixed and the armature rotates synchronously, while being supplied with two-phase alternating currents, then we have a field fixed in the iron and revolving in the space with the speed of the armature. It is thus seen that to supply two-phase currents through a commutator here has the same effect as is obtained with the rotating field of a synchronous motor when direct current is applied by means of slip rings. If such an armature is brought to synchronism in a bipolar revolving field produced by two-phase alternating currents, the armature will run as a synchronous motor, after the alternating current excitation has been started. By moving the brushes it is possible to vary the relative positions of the stator and rotor poles. If, according to Heyland's method, the commutator segments are connected together by larger non-inductive resistances, the armature will revolve in a revolving field by itself. But it is doubtful whether —especially when loaded—it will approximate synchronism sufficiently to reach synchronism and run as synchronous motor when the excitation has been started.—*Elek. Zeit.*, March 27.

Phase Displacement of Alternators and Parallel Running.—LEAKE. —An illustrated article in which he arrives at the following conclusions: The present practice of designing the rotating parts of direct-coupled generating sets for parallel running, so that the phase displacement on a load offering a constant torque shall not exceed a certain limit, is not justified by theory. A more rational method of designing the rotating parts is to proportion them so that the characteristic fluctuation of output shall not exceed a certain limit The present state of the theory of parallel running does not justify the statement that parallel running is facilitated by low frequency.—Lond. *Elec. Rev.*, April 4. 18.

REFERENCE.

Polyphase Machinery.—EBORALL.—The first part of an illustrated reprint in full of a paper read before the (Brit.) Inst. Elec. Eng., giving "some notes on polyphase machinery." He discusses standard polyphase generators and first describes the construction of the field system, details of construction being given.—Lond. *Elec. Rev.*, April 18.

LIGHTS AND LIGHTING.

Electric Lighting and Illumination.—A collection of well illustrated trade notes, comprising 16 full pages, showing the several systems of illumination now on the market in England; also new fittings and accessories, with special references to the illumination at the coming coronation. Also an article, by Cash, on "the art of design for electric illumination, domestic and public"; and a paper by Sachs, on "artistic electrical illuminations."—Lond. *Elec. Rev.*, April 11.

REFERENCE.

The Lighting of Diversey Boulevard.—CRAVATH.—An illustrated article describing the system of lighting now in use on Diversey Boulevard, Chicago, with a description of the posts, lamps, cut-outs, etc.—*Am. Elec.*, April.

POWER.

Water Tube Boilers.—BOOTH.—An article on the circulation in water tube boilers. He concludes that the small tube, nearly vertical type, is distinctly and decidedly superior, and that large tubes of flat inclination, especially when long and with many bends, are absolutely dangerous and unscientific, unless provided with very certain and positive mechanically propelled circulation—a complication perhaps justified only when applied to existing boilers.—Lond. *Elec. Rev.*, April 4.

REFERENCE.

Water Power in Ireland.—TATLOW.—A long abstract of a paper read before the Dublin section of the (Brit.) Inst. Elec. Eng., giving "notes on Irish water power and its electrical development." After general statistical notes, he describes a few places where he believes water power could be developed at reasonable cost, where it is not used at present.—Lond. *Elec.*, April 4.

TRACTION.

German Electric Railway Statistics.—The annual statistical tables, comprising 18 full pages with a large amount of information, and showing the state of the public electric railways and tramways interests of Germany up to October 1, 1901; also an editorial summary. Private roads are not included, with the only exception of the Berlin-Zossen high-speed experimental road. The trials on the latter road have shown that when a sufficiently strong roadbed is provided, higher speeds than 160 km per hour are promising for the future. On October 1, 1901, 113 German cities (against 99 in 1900) had electric traction, with a total length of roads of 3,100 km, equal to 4,550 km single track. The total capacity of the generating electric machinery in use for traction was 108,021 kw (against 75,608 kw in 1900), excluding storage batteries. The increase in the use of storage batteries was still greater; their power was 25,531 kw (against 16,890 in 1900). The total capacity of generating machines

and batteries, together, for traction was, therefore, 133,552 kw. For light and traction together, the total capacity of generating machines and storage batteries was 486,120 kw. Regardless the relation between kw and km track, as an average of 85 roads, is given 20.8 kw per km track (against 19.9, 20.5, 20.7 in 1900 1899, 1898). The average number of kilowatts per motor car was 15.7 (against 15.1 and 14.3 in 1900 and 1899). These averages have, therefore, remained nearly constant, although the values of single roads differ greatly from these averages. Of the total 4,550 km single track, only 713 km are owned by municipalities, but even this is in part rented to private companies.—*Elek Zeit,* March 27.

Electric Traction on Railways.—The conclusion of the reprint in full of Swinburne and Cooper's (Brit.) Inst. Elec. Eng. paper, and of the discussion which followed; also an editorial on the subject. In the latter it is said that the electrical engineer has at his disposal at least two systems which are suitable for the electrical equipment of railways, the continuous current constant pressure system and the high-pressure, three-phase system. There is, however, a reason not to precipitate the application of electric traction on railways: this is that a certain amount of standardization is essential for efficient traffic. Attention is called to the remarks of Carus-Wilson and McMahon on the desgin of series direct-current motors. The former thinks that the American engineers have been running off the correct lines in designing their traction motors. He points out that the great advantage in the series motor originally was held to be the possibility of obtaining in it a torque per ampere of current with a wide range of from 2 to 1. The more recent motors, however, in order to reduce weight, have enormously diminished this range, and the advisability of this step is questioned.—Lond. *Elec.,* April 18.

Electric Railway Operation.—Some notes on statements made in the Prussian Parliament by the Minister on Railways Thielen. The experiments on the Wannsee Railway with passenger trains, at a distance of 10 miles from Berlin, proved unsatisfactory, and have been abandoned; a subsequent comparison with steam had shown the economy in favor of steam, besides the greater reliability in operation. Negotiations are, nevertheless, in progress with an electrical company, for the working of freight and passenger trains by electricity from Gross-Lichterfelde to Berlin, a distance of six miles. Referring to the Berlin-Zossen high-speed experiments, he said that a speed of 100 miles per hour had been attained, but as soon as a heavier road-bed will be constructed higher speeds will be possible. The question whether such trains can be operated at a profit is still unsettled, and he considers their use limited to the conveyance of passengers. The experiments had been made with a single car, capable of accommodating about 100 persons.—Lond. *Elec.,* April 18.

Negative Boosters.—Kapp.—An illustrated translation of his German paper on inserting negative boosters in the track, which has been abstracted recently at some length in the Digest. The proposition is discussed in an editorial note. It is first asked what will be the effect of a difference of potential of 12 volts—the full load voltage of his suggested boosters—between the ends of two rails a few feet apart? Secondly, his curves apparently assume that the negative terminal of the dynamo is not earthed, as is customary in Great Britain. It suggests that, failing a return feeder, Kapp would be safer in earthing his dynamo negative and leaving his bonding continuous, than in making experiments with 12-volt boosters on the track.—Lond. *Elec.,* April 11.

REFERENCES.

Operating Cost of Tramways.—Gueroult.—A continuation of his mathematical article (Digest, Feb. 1). He first gives the general calculation of the cost of operation and the receipts and then discusses several special points, like the influence of the number of cars, etc.—*L'Eclairage Elec.,* March 22.

Car House.—A description of the Elmwood car house of the Rhode Island Suburban Railway Company.—*St. R'y Jour.,* April 5, and *Int. Ed.,* April.

Multiple Unit System.—Blakstone.—An illustrated article in which, after a discussion of the principles and distinctive features of the Sprague and of the Thomson-Houston systems of multiple unit control, he describes the Sprague system.—*L'Eelairage Elec.,* March 29.

Installations. Systems and Appliances.

British Central Station Statistics.—An editorial summary of statistical tables on electricity supply in the United Kingdom, published in former issues of this journal. Besides 15 companies which distribute electricity over large areas, there are 282 central stations, of which 96 are company undertakings and 186 municipal. The whole capacity amounts to 400,000 kw, exclusive of batteries. In the provinces there are 250 plants with 300,000 kw, in London 32 plants with 100,000 kw. An account is given of the relative proportions of company and municipal undertakings: "while the provincial municipalities utterly swamp the companies, the Metropolitan companies go far to restore the balance, and the average sizes of their undertakings are, on the whole, not very dissimilar." The vertical high-speed engine is far ahead of all others; but in several instances vertical low-speed engines have been adopted for the larger units, and the high-speed steam turbine is making steady progress, at least 22 stations being equipped with steam turbines. There are 191 direct-current stations against 91 alternating-current stations; and of the latter 24 supply also direct current, mostly for traction. Of the alternating current stations, there are eight supplying two-phase current and three supplying three-phase, the latter being used only for transmission. In no case is three-phase current distributed to consumers, though two-phase current is used freely. Fifty-six stations supply power for traction as well as for lighting and motive power. The frequency shows a marked tendency towards a standard of 50 cycles per second. Only 76 stations are entirely without a battery of more or less importance.—Lond. *Elec. Rev.,* April 11.

Wires, Wiring and Conduits.

Consumers' Installations.—Ruddle.—An abstract of a paper read before the Dublin section of the (Brit.) Inst. Elec. Eng. He urges that the Institute rules for electric installations should be adopted by general agreement. A system of official registration should be established before any person should be entitled to act as a contractor with respect to premises supplied from public distributing mains, and that such license to practice should be conditional upon the loyal observance of the officially recognized rules. He also makes a number of special suggestions, among which are the following: The supply authority's fuse box should be regarded as being essential for the protection of both the consumer and the general system against accidental disturbance or misuse, and should never be interfered with by other than the station officials. The consumer's main fuses should be of lower carrying power than those provided by the supply authority. The consumer's main switch should be fixed next to the supply authority's fuse box, followed by the consumer's main fuses. In the selection of the insulating covering of the wires and cables more attention is to be paid to securing a lasting quality of material than an abnormally high insulating test. Under no circumstances should combination gas and electric light fittings be used, even with the so-called "insulating socket." No wood casing should be used under flooring, or anywhere, except for surface work, and no fuses should be concealed or placed where they cannot be easily inspected. He recommends that the maximum drop should not exceed 1 volt, under ordinary circumstances, where the lighting is fairly dense. Where long, narrow rooms have to be wired, and the supply terminals are brought in at one end, a better average pressure results if the main cables are carried to the center of the room, and the lamps fed backward and forward from this point. Leads for arc lamps, motors, and other variable current consuming devices, should be enclosed in iron tubing, or other non-inflammable conduits. Motors of over ½-hp must be provided with properly designed and effective starting mechanism. The paper is concluded by some remarks favorable to the maximum demand system of charging—Lond. *Elec. Rev.,* April 11.

Electro-Physics and Magnetism

Form Factor and Peak Factor.—Benischke.—An illustrated mathematical article. Measuring instruments give the effective value of the alternating current or the e. m. f. On the other hand, the hysteresis depends on the maximum value of the magnetic field. For sine waves the ratio of the maximum value to the effective value is the square root of two; for other waves forms this ratio has a different numerical value; this ratio is called by him the peak factor (Scheitel Factor). He shows that the use of it gives in general more correct formulas than the use of the form factor (ratio of the effective value to the arithmetical average value). The form factor is, therefore, superfluous, and the way in which it has heretofore been applied in calculation is only correct in special cases, but is wrong in general. Moreover, the peak factor is more suitable for characterizing a wave form than the form factor, because for those wave forms which occur most generally in practice, the differences between the peak factors are greater than the differences between the corresponding form

factors. Finally the calculation of the peak factor is simpler than that of the form factor.—*Zeit. f. Elek.*, March 30.

Inductive Circuits.—BREW.—An abstract of a paper read before the Dublin section of the (Brit.) Inst. Elec. Eng., in which he gives "notes on inductive circuits." He first discusses "ferric" circuits (*i. e.*, circuits containing iron); the shunt winding of a large direct-current dynamo represents an inductive circuit. He then discusses non-ferric circuits and notices the following phenomenon: In some substations in Dublin the low pressure bus-bars on the transformer boards are coupled by rows of parallel cables to similar bus-bars on the feeder boards; it has been found that those cables which are towards the center of the group become hot at times of heavy load, while those at the edges remain cool, although the cables are all of the same section, and very approximately of the same length; by calculation of the self-inductance, it was found that for a frequency of 83, the impedance of the outermost pair is nearly 0.006 ohm, while that of the central pair is only 0.0037 ohm; for the same p. d., therefore, a larger current will pass through the central pair than through the outermost pair. He then discusses polyphase ferric and non-ferric circuits, and gives some mathematical calculations.—Lond. *Elec. Rev.*, April 4.

Electrostatic Rotary Field.—VON LANG.—An abstract of a paper read before the Electrical Society of Vienna, in which he gave the "demonstration of an electrostatic rotary field." He showed experiments in which dielectric bodies, such as cylinders of paraffine, discs of paper, glass, etc., were set into rotation in the rotary field. If the rotary field is separated by a glass cylinder from the rotating body, this does not prevent the rotation; but the rotation is prevented by enclosing the body in a metallic case or by a metallic screen. The method of production of the rotary field is not described.—*Elek. Zeit.*, March 13.

Evaporation of Charged Liquids.—BEGGEROW.—All experimental data, except those obtained by Pellat, go to show that the evaporation of a charged liquid does not convey away the charge. He repeated Pellat's experiments with additional precautions, and has studied water, alcohol, ether, mercury and various solutions. Positive and negative charges were used in each case, but no influence of evaporation upon the dissipation of the charge could be detected.—*Ann. d. Phys.*, No. 3, abstracted in Lond. *Elec.*, April 4.

Induced Radio-Activity.—HENNING.—An investigation of radio-activity induced from thorium oxide in brass plates and wires of different sizes, mounted in the axis of a closed and positively charged brass tube and receiving a negative charge. The thickness of the wire only makes a difference when the difference of potential is small, since the ions do not readily reach the cathode, and a thick wire facilitates their transfer. When the difference of potential is great, the electric field is powerful enough to bring practically all the ions into the immediate neighborhood of the wire whatever may be its diameter.—*Ann. d. Phys.*, No. 3, abstracted in Lond. *Elec.*, April 4.

Solar Corona and Comets.—NORDMANN.—An article in which he considers the sun as the source of all kinds of electromagnetic waves, although many of those are absorbed by the atmosphere of the earth. Hertzian waves should be chiefly produced in the zone of sun spots and faculæ and at the maximum of solar activity. The incandescence of the upper portions of the sun's atmosphere he believes to be due to Hertzian waves. The spectra of comets show that the incandescent gases of comets have a low temperature, something like that which obtains in discharge tubes. This fact identifies them with the incandescent gases produced artificially by means of Hertzian waves. As a comet approaches the sun, its spectrum is changed in the same way as that of a gas when the current is increased.—*Comptes Rendus*, March 3; abstracted in Lond. *Elec.*, April 4.

Hertzian Waves from the Sun.—DESLANDRES AND DECOMBE.—An article in which they point out that while Nordmann could not find that the sun emits electric waves of Hertzian dimensions, his results are not conclusive. The complete solution of the problem requires a much larger apparatus. The protuberances of the sun atmosphere ought to send out waves of great length. They propose the systematic study of these waves by means of three antennæ normal to each other. —*Comptes Rendus*, March 10; abstracted in Lond. *Elec.*, April 4.

Magnetic Action of Cathode Rays.—VON GEITLER.—He formerly described experiments which he believed to show that cathode rays exert an action on a magnetic needle. Recent researches have, however, convinced him that this effect was simulated by a thermo-electric effect which he had not suspected. He is therefore driven to the conclusion that his former results are untenable quantitatively, and possibly also qualitatively.—*Phys. Zeit.*, March 15; abstracted in Lond. *Elec.*, April 4.

REFERENCES.

Selenium Cell.—RUHMER.—An illustrated description of a new selenium cell which is said to give good results for wireless telegraphy when used in conjunction with parabolic mirrors. Its chief feature is that it is enclosed in an exhausted tube, which renders the cell more constant and reliable than previous patterns. The cell is cylindrical, and a lamp socket is provided at the bottom of the tube, convenient for connection.—*Mechaniker*; abstracted in Lond. *Elec.*, April 18.

Choking Coils.—An illustrated article giving the rules and formulas required for the construction of choking coils.—Lond. *Elec. Eng.*, Feb. 1; *Jour. of Elec.*, March.

Magnetic Induction of Electromotive Force.—A didactic article, explaining the pull on a conductor in a magnetic field. The article is illustrated by diagrams.—*Am. Elec.*, April.

ELECTRO-CHEMISTRY AND BATTERIES.

Alternating Current Electrolysis.—WILSON.—An account of an experimental investigation of this subject, which is of practical interest at present, as alternating currents are used in rail returns for traction purposes. An alternating current is passed between electrodes in an electrolyte, and the curve of p. d. between the electrolyte (by means of an auxiliary electrode, which in the compiler's opinion may involve serious errors) and one electrode and the curve of current are observed; the current curve is integrated, giving the quantity in coulombs. If the coulombs be plotted in terms of the volts the area of the resulting curve gives the total dissipation of energy per period. Energy is dissipated by what may be termed electrolytic hysteresis. In his first experiments he sent an alternating current of 0.024 ampere per square centimeter of active surface between two plates of commercial lead in dilute sulphuric acid for seven hours at a frequency of 89 periods per second. The opposing surfaces of the two plates were ⅛-inch apart and parallel. The back of each of the plates was covered by a closely fitting piece of wood. In the adjoining diagram curve No. 1 is the cyclical curve at the beginning of the test,

ALTERNATING-CURRENT ELECTROLYSIS.

and the points marked indicate the result at 89 periods per second at the end of the test. Curve No. 2 is the cyclical curve obtained at the end of the test at the frequency 22.3 and a current density of 0.007 ampere per square centimeter. At frequencies 89 and 23, respectively, the ratio of the maximum coulombs is 0.926, and the ratio of the areas of the cyclical curves is 0.854. The areas may be taken to represent work spent in electrolytic hysteresis. In the diagram, the current changes sign at the point *a* and the lead plate begins to be an anode; the work represented by the area *a b e* is negative. The plate continues to be an anode, "via *b*," until the point *c* is reached, when the current again changes sign. The work represented by the

area *b c d* is positive. At the point *c* the plate begins to be a cathode; the work represented by the area *c d f* is negative. From the point *f* to the point *a* the plate continues to be a cathode; the area *f a e* represents positive work. Taken as a whole, the area *a b c f* represents work spent upon "electrolytic hysteresis." In these experiments a considerable quantity of lead sulphate was formed and fell to the bottom of the cell. He also made experiments with pure lead electrodes and with aluminum electrodes.—Lond. *Elec.*, April 18.

Electrolytic Manufacture of Metallic Wall Paper.—A note on a German patent of Endruweit for an apparatus for producing thin films by electro-deposition. An endless metal band is first coated with potassium sulphide, and, after washing, is passed through a nickel bath. The thin film of nickel obtained in this way is backed by copper—by passing through a similar bath containing a copper salt in solution—and by tough paper, before being stripped from its support. A strong sheet or roll of paper, faced with bright metallic nickel can be obtained in this way, and the use of this material after relief-stamping and coloring, for wall papers and for advertisement show-cards is said to offer many advantages; it is also useful for packing the stuffing boxes of high pressure steam engines.—Lond. *Elec.*, April 18.

Production of Aluminum.—Askenay.—An abstract of a paper read before the Electrical Society of Vienna. He refers to the work of Haber and Seipert who found that the manufacture of aluminum on a large scale requires chemically pure materials, namely artificial cryolite free of silicum, alumina free of silicium and iron, and carbon electrodes of greatest purity. It is important to have the right temperature of the bath, which should be only slightly above the melting point of the metal. It is believed that considerable improvement may be obtained, as Bayer has succeeded in producing chemically pure alumina at low cost from bauxite.—*Elek. Zeit.*, March 13.

REFERENCES.

Direct Combination of Chlorine with Carbon.—Bolton.—An illustrated account of experiments in which the electric arc between two carbon electrodes in an atmosphere of chlorine produced a direct combination of chlorine with carbon.—*Zeit. f. Elektrochemie*, March 20.

Rotation of Electrolytes in Magnetic Fields.—Urbasch.—A reply to the recent criticism of Drude.—*Zeit. f. Elektrochemie*, March 6.

Units, Measurements and Instruments.

Cathode Rays for Alternating Current Measurements.—Morris.—An abstract of a (Brit.) Phys. Soc. paper, in which he describes an experiment illustrating the use of the cathode rays in alternating-current work. The usual form of Braun tube is used, the rays falling upon a luminescent screen and forming a blue spot. A solenoid conveying an alternating current is placed near the tube. The varying magnetic field caused the spot to oscillate about its mean position. To determine the maximum value of the current a switch is arranged to rapidly replace the alternating current by a continuous one. The continuous current is then adjusted until the maximum excursion of th spot is the same as before, and the value of the current is read off from an ammeter in the circuit. For accurate work the frequency of the discharge from the induction coil exciting the tube, should be adjusted until it is almost in synchronism with the alternating current. The unsteadiness of the spot of light in the zero position limits the accuracy of the measurements. He has tried to reduce the vibrations by using an earthed aluminum diaphragm instead of a glass one.—Lond. *Elec.*, April 18.

Growth of Electric Currents in an Inductive Circuit.—Morris.—An abstract of a (Brit.) Phys. Soc. paper. An e. m. f. of 0.8 volt was applied to a coil wound on a ring-shaped laminated iron core. When the current had attained its steady value, the e. m. f. was reversed, and the variations of the current strength shown by an ammeter. About 20 seconds were required for the current to attain its maximum value in the opposite direction. A secondary coil was also wound upon the same core, and the effect which was produced upon the growing current by the closing of this secondary circuit, was shown. He determined curves of growth for different currents. Similar curves can be used to determine experimentally the hysteresis loss of transformers. Glazebrook drew attention to the fact that this method had been applied, with some slight modifications, to the determination of the hysteresis loss in some 3,000-hp transformers.—Lond. *Elec.*, April 18.

Electric Heater.—Lehfeldt.—An abstract of a (Brit.) Phys. Soc. paper, in which he describes an apparatus consisting of a vacuum-jacketed glass tube containing water which is boiled by passing an electric current through a platinum spiral immersed in the liquid. Tap water is preferable to distilled, because the small electrolytic action in the former case causes the boiling to proceed quietly. Different temperatures can be obtained by using other liquids. It seems to be intended for obtaining a constant temperature in physical research.—Lond. *Elec.*, April 18.

REFERENCE.

American Meter Practice.—Reed.—Another article on this subject by the same author, dealing with the relation between meter losses and income, and dilating on the importance of meter maintenance and operation.—*Am. Elec.*, April.

Telegraphy. Telephony and Signals.

Wireless Telegraphy.—Lecher.—A discussion of the question why the transmission of wireless signals over distances is affected by the curvature of the earth. He thinks there is some analogy between the way in which the conducting surface of the earth affects the waves and the way in which a wire affects the same waves. As Sommerfeld has shown, a wire placed in the direction of propagation of an electric wave, produces peculiar effects. The electric oscillations are always at right angles to the surface of the wire, and a portion of the wave energy penetrates into the surface layer of the wire. It may be supposed that in a somewhat similar way the waves of wireless telegraphy run along the surface of the earth and especially of the sea, and a portion of the energy enters the earth's surface. Sea water is known to be a "good conductor" for waves of the Hertzian type. A crucial experiment would consist in sending wireless signals between two balloons of the same height, by means of vertical antennæ. Communication should be the easier the smaller their elevation. It would be interesting also to attempt to send signals up a precipice, with horizontal and vertical antennæ, respectively.—*Phys. Zeit.*, April 1; abstracted in Lond. *Elec.*, April 18.

REFERENCES.

Wireless Telegraphy in Spain.—Guarini.—An illustrated description of experiments made in Spain by Cervera, and of his apparatus, which differs in some points from the usual wireless telegraph instruments.—Lond. *Elec.*, April 18.

Wireless Telegraph in Germany.—An illustrated review of the "German wireless telegraphy systems"; that of Slaby and Arco, used by the General Electric Company, of Berlin, and that of Braun, used by Siemens and Halske.—*Elek. Anz.*, March 13, 16, 20.

Wireless Telegraphy in Germany.—Guarini.—Brief illustrated descriptions of the connections used in the transmitting and receiving apparatus in the Braun system and in the Slaby-Arco system.—Lond. *Elec. Rev.*, April 18.

Speaking Arc.—Guthe.—An illustrated paper on the use of the speaking arc in wireless telephony. He describes the experiments and arrangements of Simon, Duddell and of his own.—*West. Elec.*, April 12.

A Modern Central Energy Bell Telephone Exchange.—An illustrated article describing the new common battery exchange of the New York Telephone Company at Mt. Vernon, N. Y. The board is equipped at present for 1,000 subscribers and 170 trunk lines, but provision has been made for an ultimate increase to 3,500 subscriber lines and 340 trunk lines.—*Am. Elec.*, April.

An Independent Central Energy and Toll Line Office.—An illustrated description of the independent telephone exchange at Alton, Ill. The exchange has a capacity of 3,000 lines, and was built chiefly as a link in the long-distance system of the Kinloch Long-Distance Telephone Company, of Missouri. The system used is the common battery relay system.—*Am. Elec.*, April.

Common Battery Multiple Telephone Switchboard System.—Evans.—An article, with diagrams, describing the common battery telephone switchboard system devised by F. W. Dunbar.—*Am. Elec.*, April.

Telephone Engineering.—Dommerque.—Another of the series of articles on this subject by the same author, this one dealing specifically with the laying out of trunk lines.—*Am. Elec.*, April.

Statistical.—Articles on the effects of the telephone tariff of 1899, on the development of telephone service in Germany; on telegraphy and telephony in Germany in 1900; also in Australia; comparative notes on the extension and the importance of the telegraph service in Portugal and the Azores; on telegraphy and telephony in Belgium in 1900.—*Jour. Teleg.*, March 25.

New Books.

METHODE PRATIQUE POUR CALCULER LES MOTEURS ASYNCHRONES POLYPHASE. By Boy de la Tour. Paris: Ch. Beranger. 216 pages, 70 illustrations. Price, 12.50 francs.

The author of this book will be remembered by many American engineers as one of the delegates of the Société Internationale d'Electricité to the Pan-American Exposition at Buffalo, and they will doubtless be interested in the able work before us. Simple and lucid, with the elegance and ease characteristic of the literature of his nation, M. de la Tour presents in eight chapters the most essential points of the theory and calculation of the induction motor.

The book is divided into eight chapters, which treat successively of the rotating field in general, of the electromotive and counter-electromotive forces induced by it, of the torque exerted by this field, of the influence of the number of slots on the shape of the rotating field, of the resistance of the squirrel cage armature, of the diagrammatic representation of the phenomena in polyphase induction motors, and finally of the practical application of the theory to concrete cases.

The book is clearly written and well illustrated. In the vector diagrams, representing the phenomena in induction motors, the author follows the methods of Blondel, Behrend and Heyland. He says, on pages 141, 142: "There exists, fortunately, a graphical method which permits with the aid of a single figure to predetermine with exactness and rapidity all the conditions of running between starting and synchronism, taking into consideration with all the accuracy desirable, the important effect of the magnetic leakage.

"This method, which is certainly one of the most beautiful applications of graphical processes for the solution of electrical problems, is due to the labors of Messrs. A. Blondel, B. Behrend and Heyland. Although M. A. Blondel did not notice that a certain point in the diagram is constrained to move in a circle, he has yet contributed much to this discovery, made separately and almost at the same moment, by Messrs. B. Behrend and Heyland. Mr. Blondel gave before any other author an analytical study of the working of polyphase motors based on a very simple diagram which forms the point of departure for the circle-diagrams of the two last-named engineers."

In thus giving Prof. Blondel credit for laying the foundation for a rational treatment of the theory of induction motors, M. de la Tour merely states a fact known to all those who are familiar with the literature of alternating-current theory .

As the theoretic treatment prevalent in this book is essentially based on graphical methods by whose aid the necessary formulas have been derived in a simple and clear manner, the book is bound to arouse severe criticism in the camps of those to whom the very words "graphical treatment" have become a war-cry. But let these critics learn from the history of science that the greatest progress in new ideas has always been made by the use and aid of mental pictures, from which the formulas have been derived. So we see that Sir Isaac Newton in his Principia developed his theorems, we see Fresnel in optics build up his wave theory in this way, and, finally, we see Faraday lay the foundation of the theory of electricity entirely and completely by these mental pictures.

Clerk Maxwell has put himself on record in regard to the value of a theoretical analysis which is based primarily on graphical processes. The dynamic phenomena of rotation are doubtless among the most complex phenomena of nature. Poinsôt introduced momentum by vectors, and this is what Maxwell says about it: "We find Euler and D'Alembert devoting their talent and their patience to the establishment of the laws of the rotation of solid bodies. Lagrange has incorporated his own analysis of the problem with his general treatment of mechanics, and since his time M. Poinsôt has brought the subject under the power of a more searching analysis than that of the calculus, in which ideas take the place of symbols, and intelligence propositions supersede equations.

"If any further progress is to be made in simplifying and arranging the theory, it must be by the method which Poinsôt has repeatedely pointed out as the only one which can lead to a true knowledge of the subject—that of proceeding from one distinct idea to another, instead of trusting to symbols and equations."

Both in the theory of rotation and in that of alternating-current phenomena the use of vectors, as introduced into the theory of rotation by Poinsôt, has proved extremely advantageous, because, in the words of Maxwell, it means "proceeding from one distinct idea to another, instead of trusting to symbols and equations."

The persistent misapprehension by some men who should know better of the realisms of graphical methods is, indeed, astonishing. In alternating-current phenomena the value of the diagram consists in giving a geometrical skeleton, in which the magnitude of the vectors used can easily be expressed trigonometrically, as preferable, in vector algebra by means of complex imaginary numbers. But the superficial critics of any work in which graphical processes are used to some extent, raise a hue and cry against its author, accusing him of a contempt for mathematics or worse. If they will only take the pains to familiarize themselves with the combination of geometrical and analytical methods, they will, to again cite Maxwell, "Find themselves very much enlightened during the process, and will even be doubtful whether the ideas as expressed in symbols had ever quite found their way out of the equations into their minds."

THE LAWS OF RADIATION AND ABSORPTION. Harper's Scientific Memoirs. Edited by D. B. Brace, Ph. D. New York: American Book Company. 131 pages, illustrated. Price, $1.00.

A new volume of the series of *Scientific Memoirs* is always a welcome arrival, putting as it does before the reader a group of allied papers dealing with some important topic of physical science, and gathered often from sources quite inaccessible to the ordinary student.

The present book takes up the development of the theory of radiation and absorption, beginning with the classical papers of Prévost, from which sprang the "Theory of Exchanges," and following through the telling researches of Stewart to the culmination of the work in the great papers of Kirchhoff and Bunsen, that form the basis of spectrum analysis.

Prévost's two memoirs make particularly interesting reading, forming as they do almost the beginning of thermal science. They are based, like the fundamental work of Carnot, on heat as a form of matter. The scientific gentlemen of the present day who are busy investigating the properties of electrons may find in Prévost's opening paragraphs some hints worthy their attention. In fact, Prévost's work gives a beautiful demonstration of the independence of fluent quantities from particular conceptions of their physical nature.

To the ordinary reader the most interesting part of the volume is the translation of the epoch-making research of Kirchhoff and Bunsen. It is hard to realize at this day the profound sensation which it produced in the scientific world, but it is even now vastly instructive and forms the best possible introduction to the study of spectrum analysis.

The editor has furnished brief biographical sketches of the various authors, and has also added a very useful bibliography of the subject, including the most important papers which have been published up to date. It is a pity that the observations of Foucault, on the reversal of the D lines, were not translated in full instead of merely mentioned in a foot-note, since the original is not easily obtained, and fruitless as the observation was at the time, it was very important.

Directory of Electrical Societies, Etc.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS. Annual business meeting, New York, May 20; annual convention, Great Barrington, Mass, June 18—21, 1902.

AMERICAN STREET RAILWAY ASSOCIATION. Next meeting, Detroit, Mich., Oct. 8, 9 and 10, 1902.

ASSOCIATION OF RAILWAY TELEGRAPH SUPERINTENDENTS. Next meeting, Chicago, June 18, 1902.

ASSOCIATION OF EDISON ILLUMINATING COMPANIES. Next meeting, September, 1902.

CANADIAN ELECTRICAL ASSOCIATION. Next meeting, Quebec, June 11, 12 and 13, 1902.

ENGINE BUILDERS' ASSOCIATION OF THE UNITED STATES. Next meeting, Pittsburg, Pa., May 22 and 23, 1902.

INDEPENDENT TELEPHONE ASSOCIATION OF WISCONSIN. Next meeting, Waupaca, Wis., June 25, 26 and 27, 1902.

NATIONAL ELECTRIC LIGHT ASSOCIATION. Next meeting, Cincinnati, Ohio, May 20, 21 and 22, 1902. (See programme on page 804.)

NEW YORK STATE STREET RAILWAY ASSOCIATION. Next meeting, Caldwell, N. Y., Sept. 9 and 10, 1902.

Northwestern Electrical Association. Next meeting, Waupaca, Wis., June 25, 26 and 27, 1902.

Ohio Street Railway Association. Next meeting June, 1902.

Wireless Telegraph Bids.

At Washington, on May 6, Gen. Greely, chief signal officer, opened bids for wireless telegraph service in Alaska, where the ordinary cables fail in important points, owing to climatic conditions. The principal connection wanted was across the waters of Norton Sound, connecting Fort Davis, Cape Nome, with St. Michael, either by one circuit or by a relay on Stuart Island. In the latter case, or "A" route, the greatest uninterrupted distance would be ninety miles; in the first or "B" case, the stretch would be about 108 miles. The department also called for bids for systems between Rampart City and Winter Houses, a distance of 136 miles, or preferably between Fort Gibbons and Bates Rapids, a distance of 165 miles from the seacoast inland. Five bids were received, and another bid is on the way from the Arco-Slaby Company, of Germany. Foote, Pierson & Co., of New York, offered to supply four sets of instruments in guaranteed working order for $28,800. Queen & Co., of Philadelphia, who are the makers of the apparatus of Prof. R. A. Fessenden, with which the Weather Bureau has been experimenting, offered to put in the system on Route "A" for $6,000, and Route "B" for $7,000. Masts would be supplied for $4,000 extra, and a speed of from twenty-five to thirty words a minute would be guaranteed. This company did not regard it as feasible to communicate overland in Alaska, but proposed a system from St. Michaels to the nearest coast point opposite Rampart City, and a land wire leading in.

The Marconi Company complicated its bid by a provision for royalties, and division of commercial business. It offered to put in the "B" route for $9,919, and the "D" route for $11,005. In addition the company wanted a royalty of $250 per annum for each station, and one-half the receipts from commercial business.

A Belgian Invasion of America.

Mr. Ernest Solvay, of Brussels, has recently organized what is known as the Institute for Sociology, under the direction of Professor Waxweiler, who was formerly the head of the Labor Bureau at the Ministry of Labor, and a professor in the University. The institute is to be installed in Leopold Park, the city of Brussels cooperating by giving the necessary land. Monsieur Solvay has provided for the operating expenses, and at the end of 25 years the building, with its contents, will revert to the state. The museum contains a large central hall with small rooms suitable for research and class instruction, a library with special departments devoted to statistics, commercial geography, the economics of history, and a technical department, which will contain photographs, charts, diagrams and documents explaining industrial processes, and, in general, the interpretation of technical processes in their application to modern business. Methods of invention and organization will receive particular attention.

M. Waxweiler, the director of the Institute, has commended to the Industrial Bettterment Department of the New York League for Social Service most warmly, M. de Leener, civil engineer and scientific assistant at the Institute, his representative, who is now in this country, studying our industrial problems. The Solvay Institute of Sociology will interest itself with the same subjects as the League for Social Service, but its methods will be somewhat different. The Institute has been founded for the purpose of giving every one desirous of studying social questions suitable facilities. It will not concern itself with questions of politics or religion or industrial conflicts, as between capital and labor. Its purpose will be scientific exclusively. The Institute will not give general information to the public, but, of course, it will help in every possible way foreign students or scientists coming to Belgium. In short, it is a laboratory for the study of social questions.

The League has placed its New York offices at the disposal of Mr. de Leener, who is especially desirous of securing photographs of shops, mills and factories, particularly the installation of machinery and the operation of automatic machines and labor-saving devices, such as electric motors, etc. Catalogues, special circulars, and whatever will interpret the use of the machine or device in question, are also desired by him for the Institute's technological department. All illustrative material will be fully credited to the individual or firm sending it, making special mention of the industry in question. It will be labeled with the name of the donor, and will be publicly acknowledged in the bulletins and in the review published by the Institute. All material for the Institute may be sent to the League, for M. de Leener, who will forward it to Brussels. Its receipt in New York will also be acknowledged.

If Americans will send the Institute photographs of their machines or of finished products, this material will come directly under the notice of those who are fitting themselves for positions as superintendents, managers and owners, where they will need just such machines and goods as they are making. Then, too, when they or their representatives are in Brussels, the facilities of the Institute will be at their disposal, so that they will be able to observe what other countries are doing along their own lines. Mr. de Leener's headquarters in New York are the offices of the League for Social Service, 287 Fourth Avenue.

Automatic Circuit-Breakers.

We illustrate herewith four types of magnetic blow-out automatic circuit-breakers for 500-volt direct-current circuits, made by the General Electric Company. The blow-out feature has been introduced for the reason, it is stated, that the only commercially practicable way of breaking direct currents at 400 volts and above is by the use of the magnetic field, which destroys the arc the instant of its formation, and, therefore, promptly and positively opens the circuit and prevents injury to the contacts. In these circuit-breakers the tripping point is adjustable to any desired current from 50 below to 50 per cent above the rated capacity, by adjustment of the calibrating spring of the tripping armature.

Fig. 1 shows a circuit-breaker having a capacity of from 150 to

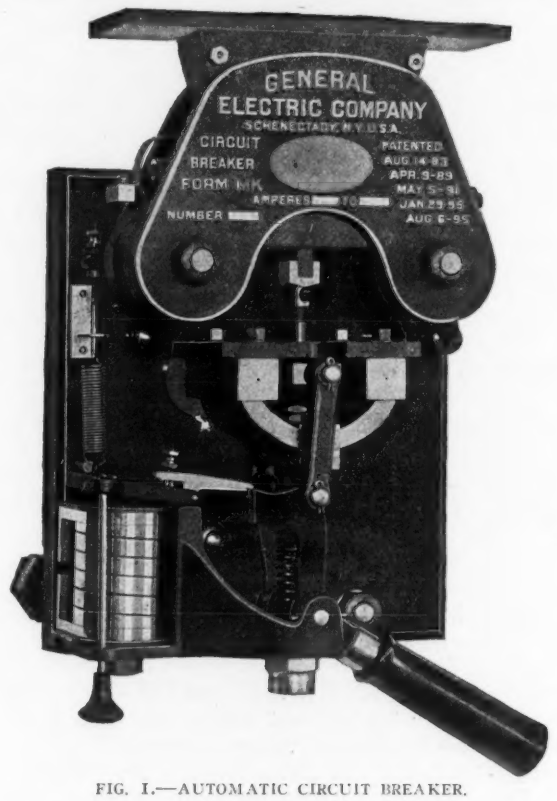


FIG. 1.—AUTOMATIC CIRCUIT BREAKER.

2,000 amperes, and Fig. 2 one having a capacity of 3,000 to 10,000 amperes. These forms are especially intended for severe service, such as on generator and feeder panels, where the circuit is subjected to repeated and violent overloads. Destructive arcing is prevented by the use of supplementary contacts placed in a strong magnetic field, and arranged so as to break the circuit a moment after the current contact. The latter contact, which is built up of leaf springs, bears upon the main contact blocks when the breaker is closed. The coils of the blow-out magnet, and the secondary or plug contacts, are in multiple with the main contact. Owing to the comparatively higher resistance of the secondary contacts, practically no current passes through them until the main contact opens; then the

whole current passes through the magnet coils, and the strong magnetic field extinguishes the arc as soon as it is formed on the plug contact. The plug is not withdrawn until after the leaf contacts have left the contact blocks.

The circuit-breaker of Fig. 2 differs from that of Fig. 1 in the main brush, the manner of tripping, the arrangement of the secondary contacts, and in the dash-pot. The necessary power for tripping is obtained from a magnet, which is made in the form of a strap, encircling one of the main studs at the rear of the panel. Studs are carried through the panel to support the armature and form the necessary magnetic circuit; the armature spring and scale plate are, therefore, in front of the panel in an accessible position. The secondary contacts are held in place by a hinged clamp, and are so arranged as to be easily removed upon taking off the plate piece. The dash-pot has an air cushion, which permits the use of a strong spring to increase the speed of opening of the main brush, and lessen the shock.

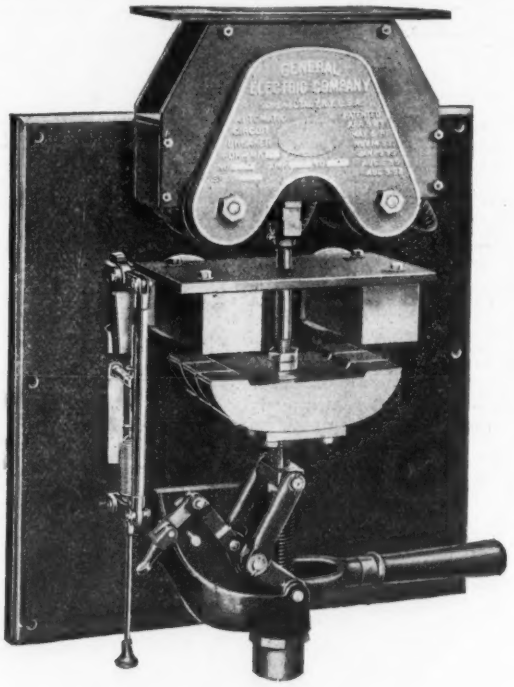


FIG. 2.—AUTOMATIC CIRCUIT BREAKER.

Figs. 3 and 4 show a circuit-breaker for use in small power plants where the conditions are not severe. Fig. 3 shows the instrument front connected, and Fig. 4 shows it back connected. This circuit-breaker is made for 100 to 500 amperes for front or back connection, and 200 to 800 amperes for back connection only. This, as well as the first two mentioned circuit-breakers, is supplied with an automatic locking handle. When the circuit-breaker is open, it is locked by removing the handle; and, when closed, the handle cannot be removed.

Fig. 5 shows a circuit-breaker which is made only up to 170 amperes, and is designed especially for protecting power circuits and stationary motors. As will be seen, in general principles it is somewhat similar to those shown in Figs. 3 and 4, but it has no secondary contact; it is, however, provided with arcing tips to protect the main contacts. The current is broken on a segmental contact similar to those used in railway trolleys. There is but one coil for both the tripping magnet and the magnetic blow-out, and the magnetic circuit is so arranged that the arc is ruptured in its field.

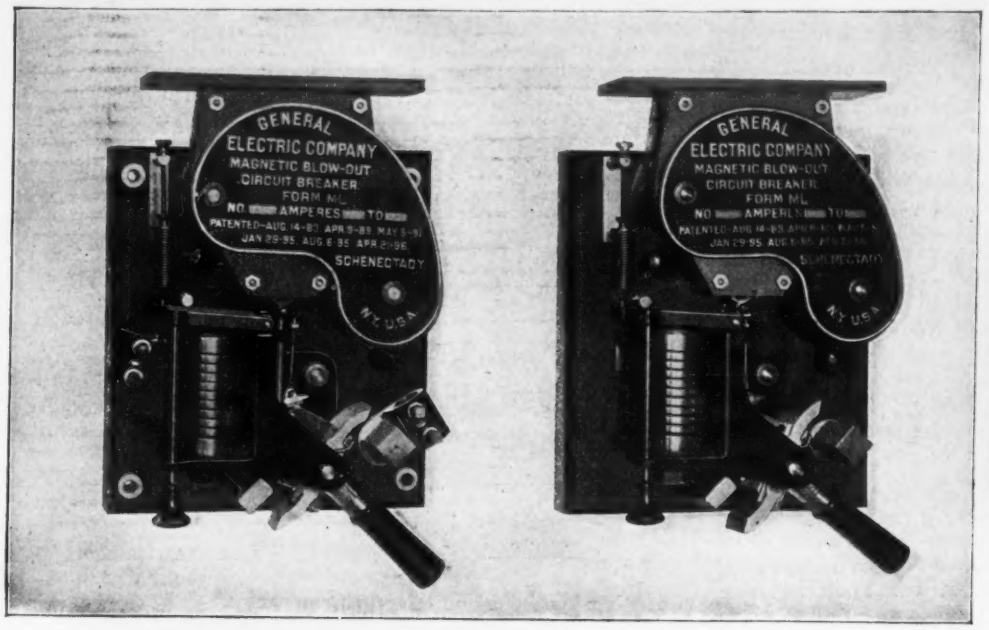


FIG. 3.—FRONT CONNECTED CIRCUIT BREAKER.

FIG. 4.—BACK CONNECTED CIRCUIT BREAKER.

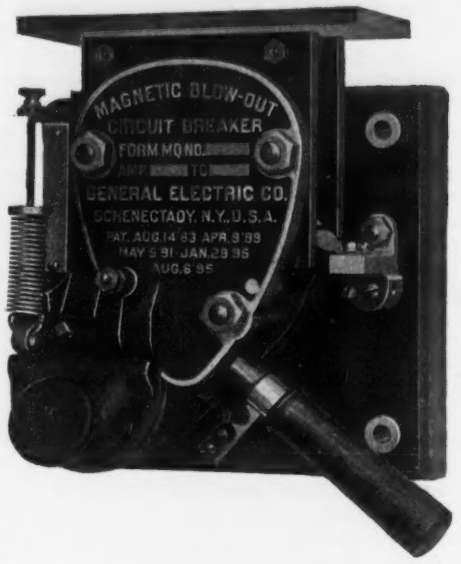


FIG. 5.—AUTOMATIC CIRCUIT BREAKER.

A New Telephone.

Owing to the rapid increase of private line telephones there is a growing demand for a first-class inexpensive telephone—that is, an instrument which "talks" perfectly, rings perfectly, which will not get out of order, and also finished in the manner that becomes telephone apparatus.

The Atwater-Kent Mfg. Works, of Philadelphia, has devoted a large amount of time and considerable expense in developing an instrument of this type, which is now being placed on the market under the name of the "Monoplex" telephone. A number of advantages are claimed for this type for use on short lines.

MONOPLEX TELEPHONE.

The hook has a long lever, and consequently there is a maximum motion at the contacts with the least motion of the hook. The receiver is of the watch-case type, and aside from the rubber ear cap is in one piece. There is thus no chance for a change in adjustment or of parts becoming loose. All connections are soldered, and the binding posts are so marked that there is no chance of mistake in connecting. Two wires are all that are needed between any two instruments, and complete directions for setting up are sent with each telephone. The Monoplex telephone will talk over a distance of three miles, and is thus admirably adapted for use in office, factories, hotels, apartments and private houses.

NEWS OF THE WEEK.

Financial Intelligence.

THE WEEK IN WALL STREET.—Money on call closed at 6 per cent. nominally; time money was in fair demand, closing at 4 @ 4¼ per cent. for thirty to sixty days. In spite of the high rates for call money, and sensational breaks in manipulated specialties, the general stock market was strong with an advancing tendency. New high-price records were made in a number of leading stocks, but the market on Friday declined in consequence of the fall in various specialties and "curb" stocks, the principal of which was International Power. This stock at one time advanced to 199, but dropped during the course of the week to 85, closing on Saturady at 90; the net loss for the week being 103 points. Steel stocks were dull and heavy, being unfavorably affected by reports about the company's position. There was general weakness in tractions and electric stocks, and all showed net losses on the week's business, with the single exception of Westinghouse 1st pfd., which closed with a net gain of 3 points. Westinghouse common closed at 220 ex-div., being a net decline of 5¼ points. General Electric was off 5 points, closing at 323; and Western Union ⅞-point, the closing quotation being 91⅜. Brooklyn Rapid Transit closed at 67⅛, being a net loss of 3⅛ points, and Met. St. R'y at 150½, a net loss of 1¾. Am. Telephone and Telegraph closed at 181 in New York, being a net loss of 2¾ points; in Boston it remained unchanged. American Dist. Telegraph rose to 40, thus making a net gain of 1½ points. In Boston, Western Telephone common closed at 28½, and preferred at 102. The closing quotations of May 6 follow:

NEW YORK.

	April 29.	May 6.		April 29.	May 6.
American Tel & Cable..	85	88	General Electric	326½	326
American Tel. & Tel.....	180	181½	General Carriage	15⅞	3
American Dist. Tel.....	38	39½	Hudson River Tel.....	100	—
Brooklyn Rapid Transit..	70½	67⅜	Metropolitan Street Ry...	152⅛	151
Commercial Cable	150	150	N. E. Elec. Veh. Trans..	13¾	14¼
Electric Boat	35	33	N. Y. & N. J. Tel.....	166	—
Electric Boat pfd.....	50	50	Tel. & Tel. Co. America..	—	4½
Electric Lead Reduc'n...	3⅞	—	Western Union Tel.....	92⅜	91½
Electric Vehicle	7	7	West. E. & M. Co.....	224	219
Electric Vehicle pfd.....	12½	—	West. E. & M. Co. pfd....	225	220

BOSTON.

	April 29.	May 6.		April 29.	May 6.
American Tel. & Tel.....	183½	181½	Mexican Telephone	2½	2¼
Cumberland Telephone..	129	—	New England Telephone..	150*	150*
Edison Elec. Illum.....	—	—	Westinghouse Elec.	—	—
Erie Telephone	—	—	Westinghouse Elec.pfd...	—	—
General Electric pfd.....	326	—			

PHILADELPHIA.

	April 29.	May 6.		April 29.	May 6.
American Railways	46	—	Phila. Traction	97¾	97½
Elec. Storage Battery...	86½	91½	Philadelphia Electric ...	5⅜	5⅝
Elec. Storage Batt'y pfd.	86½	91½	Pa. Electric Vehicle	1¾	—
Elec. Co. of America.....	7⅛	7⅛	Pa. Elec. Vehicle pfd....	5	—

CHICAGO.

	April 29.	May 6.		April 29.	May 6.
Central Union Telephone.	—	—	National Carbon pfd.....	91	89
Chicago Edison	167	170	Northwest Elev. com.....	37¼	38
Chicago City Ry.....	224	215	Union Traction	22¼	21
Chicago Teleph. Co.....	—	—	Union Traction pfd.....	59½	56
National Carbon	25⅛	25¼			

*Asked.

CHICAGO EDISON COMPANY REPORT.—The Chicago Edison Company has issued its annual report for the year ending March 31, 1902. The latest showing surpasses all previous reports in that the net earnings amount to the million mark for the first time, the exact sum being $1,085,789.71, against $902,959 last year, $812,390 in 1900, $740,256 in 1899, and $327,854 in 1892. Dividends of $515,982 were paid during the year, with $300,983 of fixed charges. The allied Commonwealth property earned net $271,763, against which the fixed charges were $167,260. In the previous year the Chicago Edison net was $902,958, and the Commonwealth $218,871. President Insull is to be congratulated upon the brilliant success of his administration, at once progressive and conservative.

LEASE OF PHILADELPHIA TROLLEYS.—At a special meeting, on May 5, of the stockholders of the Union Traction Company, which controls all of the street railway lines in this city, resolutions were adopted favoring the lease of the company's franchises to the Philadelphia Rapid Transit Company, and empowering the officers to execute the lease which becomes operative July 1. Of the 600,000 shares of the company, 442,623 were voted in favor of the project. Another resolution was adopted empowering the Directors to issue $1,500,000 fifty-year, 4 per cent. collateral gold bonds to fund the company's debt. The lease is for a period of 999 years.

TROUBLES IN DENVER.—The Denver Gas and Electric Company has confessed judgment in a suit brought by Dennis Sullivan to collect a note for $15,000, and on application of plaintiff, H. L. Doherty was appointed receiver for the company. The company is capitalized for $3,500,000, of which $2,650,000 is outstanding. It has authorized an issue of $5,500,000 gold bonds, and is responsible for $2,300,000 of 6 per cent. bonds now out. Its available cash assets are $250,000, and liabilities $500,000. It has been in financial troubles since it lost the contract for street lighting, over which litigation is pending.

KANSAS CITY MERGER.—It is understood in banking circles that as a result of the prolonged visit of representatives of the Armour interests to Kansas City radical and important changes are about to be made in the Metropolitan Street Railway Company and the Kansas City Electric Light Company. According to the reports the two companies are to be consolidated. The companies are capitalized at $33,000,000.

INTERNATIONAL POWER, with which Mr. J. Hoadley is prominently connected, has had violent fluctuations the past week, in connection also with General Carriage, under kindred control. The collapse of these securities has carried down more than one house in Wall Street, and has hurt the market generally. The underlying values have been hard to determine, and a feeling of insecurity has resulted.

KEYSTONE TELEPHONE.—In a circular just issued, the Keystone Telephone Company, of Philadelphia, says: "There have never been any negotiations to sell to the Bell Company, and all reports to that effect have been inspired by persons unfriendly to our interests; furthermore, there is a State law prohibiting a combination of competing telephone and telegraph companies."

BOSTON EDISON.—A special meeting of the stockholders of hte Edison Electric Illuminating Company, of Boston, is called for May 14, to vote on increasing the capital stock. The business of the company is growing with unparalleled rapidity, and plant must be installed to keep pace with it. President Edgar has been in New York during the past week.

ORDERS FOR LIGHTING PLANT.—It is stated that the Norristown, Pa., Electric Light and Power Company has just placed orders for three Ames engines of 250, 225 and 100 hp, two 250 hp Heine boilers, a Weber stack, 150 feet high, and General Electric dynamos, to be direct connected. Mr. D. A. Bertolette is superintendent.

BELL INSTRUMENTS.—The increase of 31,436 instruments in the net output of the American Telephone and Telegraph Company for the month ended April 20 is reported, as compared with the same month last year.

NEW HAVEN TROLLEYS.—An increase has been made in the capital stock of the Fair Haven and Westville Street Railway, New Haven, Conn., from $3,000,000 to $5,000,000.

GENERAL ELECTRIC STOCK.—At Schenectady, on May 5, General Electric stockholders voted to increase its capital stock to $45,000,000.

Commercial Intelligence.

THE WEEK IN TRADE.—Reports received by the mercantile agencies indicate that the seasonable weather throughout wide areas has helped distribution at retail, and improved re-order business with wholesalers. There are some exceptions, however, due to conditions affecting crops. In all industrial lines exceptional activity continues. In the building trades there is an active demand for material of all kinds, and the extreme activity continues. All obtainable measures of April trade point to its having been a satisfactory month. New business in iron and steel was generally in small lots, not because the demand is smaller but because supplies will not admit of large deliveries. A rather unique situation in the rail market is the price of old rails fit for relaying, which were held $4 above the nominal price for new rails. Slow deliveries of standard sections interfere with important terminal work at Pittsburg and other points. Finished products are scarce and high, and some mills are booked with orders far into 1903. Some very large orders for structural material were placed during the week. The number of business failures during the week, as reported by Bradstreet's, aggregated 174, as against 181 the week previous, and 163 the same week last year. The copper market remains quiet; transactions were few and of light volume. Prices are slightly lower, Lake being quoted at 11¾ @ 12c.; electrolytic in cakes, wire bars and ingots 11⅜ @ 11½c.; in cathodes 11⅛ @ 11¼c., and casting stock at 11¼ @ 11⅜c.

ELECTRIC PLANT FOR BRAZIL.—Labria, located in the wilds of Brazil, about 700 miles in a southwesterly direction from Manaos, is to have a complete up-to-date Yankee electric plant, which will be the first of its kind in that part of the world. The outfit, which will entail an expenditure of nearly $11,500 before it reaches its ultimate destination, is intended for lighting and pumping purposes, the water now used in Labria being conveyed from the river to the town by means of hand buckets. The plant is to consist of a 30-kw direct-connected generator, to be built by the C. & C. Electric Company; an engine of 50-hp from the Harrisburg Foundry and Machine Works, a Babcock & Wilcox water-tube boiler, a C. & C. switchboard, etc., and a triplex pumping outfit, which has not yet been ordered. There being no railroad within at least 1,000 miles of Labria, the plant will, on arrival at Manaos, be placed on a lighter and hauled up the river Purus to its destination. The time in transit from Manaos will be almost 15 days, and the freight charges alone will exceed 50 per cent. of the New York cost of the plant. The contract was secured through the Brazilian house of Bytton Brothers, whose New York offices are 117 Pearl Street, New York. The chief engineer of the firm, Mr. Charles A. Seibert, formerly connected with the C. & C. Electric Company and the Sprague Electric Company, who has come up from Brazil in connection with the Labria and other contracts, stated to a representative of the ELECTRICAL WORLD AND ENGINEER that negotiations are also being carried on with other small towns in Brazil for the installation of somewhat similar plants, and that there is an important market waiting development in that part of the world for small dynamos, ranging, say, from 5 hp to 10 hp, to be driven by kerosene oil engines. These outfits are wanted chiefly for lighting purposes on plantations. Mr. Seibert, according to present arrangements, will return to Brazil in about six weeks.

BUFFALO FORGE COMPANY.—The usual brisk demand for goods manufactured by the Buffalo Forge Company, of Buffalo, N. Y., is reported. Among the many contracts recently awarded to them might be mentioned the equipment of the Pennsylvania Steel Company's forge shop, at Philadelphia, Pa., with 20 down-draft forges, by means of which all smoke and gases are immediately and completely exhausted. Three large fan system heating plants for the Lake Shore and Michigan Southern Railroad shops, of Collinwood, Ohio, may also be mentioned. This contract consists of the heating and ventilating of the woodworking mill, passenger coach, paint shop, and the freight car repair shop. The Bowery Bay Building and Improvement Company, New York City, are to be furnished with a 200-hp horizontal, center-crank engine for electric lighting plant. This firm bought the company's engine awarded a gold medal at the Omaha Exposition in 1898, which has been in active service at their plant since date of purchase. The order now entered calls for the same type engine of a larger horse-power. The Buffalo Forge Company are also to furnish the Seaboard Realty Company, of New York, N. Y., six 120-hp engines and two 95-hp engines for the electric lighting plant of this company.

YANKEE METHODS and British workmen are still performing feats that startle the English public, which has hardly had time to cease from wondering at the records made in brick laying at the British Westinghouse Company's works, at Manchester, when it is called upon to admire the huge chimney stack of the generating station of the Mersey Railway Company, at Liverpool. Begun about Christmas time, the stack, which is about 250 feet in height, has been completed already, and stands a record-breaker, as far as expedition in building is concerned. The work has been carried out by the British Westinghouse Company, who have the contract for converting the Mersey Railway tunnel from steam to electric traction, and the work has been done by British labor under the direction of Messrs. J. Stewart & Co., famous for record-breaking time in the construction of the Manchester Works, the Galveston Docks and the renowned grain-elevator, "Kalumet K." From nearly every part of Liverpool the Mersey chimney, decorated with the American and British national flags, stands out plainly on the sky-line as the highest structure in that part of Cheshire.

COOLING AND CONDENSING PLANTS FOR ENGLAND.—The Wheeler Condenser and Engineering Company, 120 Liberty Street, has received the contract to supply three sets of cooling towers for the Stuart Street Station, of the Manchester Corporation Tramways. The plant is to be capable of dealing with 300,000 gallons of water per hour. Other British contracts recently secured include one for a cooling and condensing plant, to be installed in the Lister Drive Station, at Liverpool, to deal with 42,000 pounds of steam hourly. Another order is for extensions at the London United Tramways power house, Chiswick. This comprises a cooling tower with condensing plant, capable of handling 30,000 pounds of steam. There is also under order a cooling tower and condensing plant for the station at Lowestoft, and a similar equipment for a power house at Helsingfors, Finland. Five large sets have also been recently requisitioned for the Great Northern Railway power station, London, and a set each for the Erith, Blackheath and Greenwich electric light stations.

U. S. EXPORTS.—The United States maintains its position at the head of the world's exporting nations, despite the temporary reduction in the value of exports due to the shortage in corn available for exportation. The export figures for the nine months ending with March, as shown by the report of the Treasury Bureau of Statistics, indicate a drop of $58,681,957 in the total value of exports. When it is considered, however, that the value of corn exported fell, owing to the shortage in the corn supply, fifty-two million dollars below that for the corresponding period of last year, and that cotton, owing solely to a decrease in price, fell twelve million dollars below the exports of the same period of last year, the entire decrease is more than accounted for. Notwithstanding the reduction of fifty-nine millions in exports, the grand total of domestic exports from the United States exceeds that of any other country. The figures of domestic exports for the nine months ending with March are: From the United States, $1,062,432,158; United Kingdom, $1,019,466,437.

THE WESTINGHOUSE ELECTRIC & MFG. CO. has made an agreement with the Lorain Steel Company, whereby the Westinghouse Company acquired on May 1 the electric railway equipment business of the Lorain Company, formerly carried on under the name of the Steel Motor Company, at Johnstown, Pa. The Westinghouse Company will still continue to maintain the works at Johnstown, and sell the "Steel Motor" as an adjunct to its own electric railway business. It is important to note that, in view of the fact that the Westinghouse Company now controls the manufacture of the Lorain motors, these equipments hereafter shipped may be supplied with the nose spring suspension, covered by the patents controlled by the Westinghouse and General Electric Companies.

WAGNER MOTORS FOR BRAZILIAN PRINTING PLANT.—The state printing plant at Manaos, Brazil, is to be equipped with a number of small American motors, intended for printing presses, paper cutters, etc. Orders have already been placed through the export house of Bytton Brothers, for eight Wagner single-phase machines, varying from ½ to 2½ hp. Power to drive these motors will be derived from the existing Yankee electric lighting plant in that Brazilian city.

MOTORS FOR CEMENT WORKS.—The Sprague Electric Company has been awarded the contract for furnishing all the electric motors and generators to be used in the cement works at Hannibal, Mo. The order was given by the Atlas Portland Cement Company, which is the largest cement manufacturing company in the world, and the equipment consists of three 400-kw engine-type, split-pole generators and over seventy motors, ranging in sizes from 15 hp to 125 hp.

MR. EMMANUEL TSAKONAS, of Athens, Greece, advises us that he has established there a firm known as "Enterprises Generales D'Eclairage, Emmanuel Tsakonas," to supply electric light, power and acetylene apparatus. He has been engaged in business for some years with his brother. Catalogues, etc., should be forwarded to 45 Rue de Stade, Athens.

WESTINGHOUSE, CHURCH, KERR & CO. have been appointed engineers by the Pennsylvania, New York and Long Island Railroad Company for the construction of the electric underground road to connect the Pennsylvania railway at Newark with the Long Island Railway at Long Island City.

ENGINES FOR BEET SUGAR PLANT.—Two engines, built by the Ball Engine Company, Erie, Pa., direct-connected to Crocker-Wheeler generators, will be used to furnish electric light and power for the new beet sugar plant of the Macomb Sugar Company, Mt. Clemons, Mich.

POWER EQUIPMENT.—The Chillicothe Electric Railway, Light and Power Company, Chillicothe, Ohio, is preparing to make purchases of power equipment for its new power house. General Superintendent Joseph Myers was in Cleveland recently securing estimates.

IRON WORK CONTRACT.—The Milwaukee Electric Railway and Light Company will soon let the contract for the iron work for its new general office building, central car house and terminal station in this city. The building will be 320 feet by 200 feet, and five stories high.

LIGHTING PLANT PROJECTED FOR HONDURAS.—A scheme for the establishment of an electric lighting plant in Belize, British Honduras, is at present under consideration. In all probability the machinery will be purchased in the United States.

THE ONONDAGA DYNAMO COMPANY, Syracuse, N. Y., have contracted with H. B. Coho & Co. (Inc.), 149 Broadway, New York, to represent it in the sale of "Onondaga" dynamos and motors in New York, New Jersey, Philadelphia and New England.

LIGHTING AND POWER EQUIPMENT.—Electric lighting, power equipment and electric elevators will be required for a large power building to be erected in Cleveland by J. V. N. Yates. Watterson & Clague have the contract.

EXPORTS OF ELECTRICAL MATERIAL.—The following are the exports of electrical materials and machinery from the port of New York for the week ended April 25: Antwerp—21 pkgs. material, $1,869; 2 pkgs. machinery, $90. Amsterdam—1 pkg. material, $11. Argentine Republic—52 pkgs. material, $1,317. Brazil—108 pkgs. material, $7,319; 4 pkgs. machinery, $410. British Australia—8 pkgs. material, $353; 54 pkgs. machinery, $13,268. Bremen—10 pkgs. material, $90. British East Indies—37 pkgs. material, $2,339; 6 pkgs. manufactures, $1,380. Breslau—2 pkgs. machinery, $19. British West Indies—6 pkgs. material, $75. Cuba—482 pkgs. material, $5,245. Central America—10 pkgs. material, $96. Chili—3 pkgs. material, $41; 1 pkg. machinery, $116. Christiana—1 pkg. material, $12. Copenhagen—3 pkgs. machinery, $121. China—15 pkgs. machinery, 375. Dutch West Indies—2 pkgs. material, $20. Dublin—41 pkgs. machinery, $4,345. Ecuador—42 pkgs. material, $672. French Possessions in Africa—2 pkgs. material, $250. Frankfort—1 pkg. material, $21. Glasgow—67 pkgs. material, $1,927; 1 pkg. machinery, $45. Hong Kong—24 pkgs. machinery, $750. Havre—19 pkgs. machinery, $851; 5 pkgs. material, $220. Hayti—11 pkgs. material, $106. Hamburg—16 pkgs. material, $794. London—262 pkgs. machinery, $15,569; 138 pkgs. material, $3,890. Liverpool—258 pkgs. machinery, $10,192; 34 pkgs. material, $1,293. Manchester—3 pkgs. material, $175; 361 pkgs. machinery, $45,012. Mexico—404 pkgs. material, $3,517; 3 pkgs. machinery, $263. Milan—4 pkgs. material, $2,500. Newcastle—13 pkgs. machinery, $964. Newfoundland—11 pkgs. material, $160; 1 pkg. machinery, $100. Nova Scotia—1 pkg. machinery, $23; 36 pkgs. material, $443. Naples—5 pkgs. material, $300. Nice—9 pkgs. material, $350. New Zealand—172 pkgs. material, $1,255; 86 pkgs. machinery, $10,000. Peru—37 pkgs. material, $1,499. Philippines—375 pkgs. material, $9,170. Siam—31 pkgs. material, $2,310. Southampton—103 pkgs. machinery, $6,350; 5 pkgs. material, $904. Santo Domingo—13 pkgs. material, $191. Stockholm—5 pkgs. machinery, $418. U. S. Colombia—12 pkgs. machinery, $180; 109 pkgs. material, $557. Venezuela—8 pkgs. material, $320. Zurich—3 pkgs. machinery, $95. Following is a list of the exports from New York during the week ending May 3: Antwerp—7 pkgs. material, $756. Argentine Republic—1 pkg. material, $186. British West Indies—12 pkgs. material, $103. British East Indies—55 pkgs. material, $7,974; 1 pkg. machinery, $107. Bremen—16 pkgs. material, $1,807. British Guiana—41 pkgs. material, $916. Bradford—2 pkgs. fire alarm machinery, $180. Brazil—32 pkgs. material, $1,280. British Australia—40 pkgs. machinery, $1,716; 140 pkgs. material, $9,799. Berlin—2 pkgs. material, $50. British Possessions in Africa—1 pkg. machinery, $45. Cuba—1 pkg. machinery, $125; 58 pkgs. material, $1,428. Central America—124 pkgs. material, $1,068. Copenhagen—2 pkgs. machinery, $500. Chili—9 pkgs. material, $314. Christiana—2 pkgs. machinery, $88. Dutch Guiana—1 pkg. material, $32. Dublin—15 pkgs. material, $975. Glasgow—3 pkgs. material, $121. Havre—25 pkgs. material, $1,572; 6 pkgs. machinery, $371. Hamburg—2 pkgs. material, $60. London—44 pkgs. machinery, $3,075; 235 pkgs. material, $5,198. Liverpool—155 pkgs. machinery, $9,409; 86 pkgs. material, $4,160. Mexico—28 pkgs. material $911; 17 pkgs. machinery, $3,596. Manchester—871 pkgs. machinery, $62,632. Newcastle—14 pkgs. motor machinery, $1,340. Rotterdam—7 pkgs. machinery, $1,379. Southampton—20 pkgs. machinery, $4,800; 4 pkgs. material, $190. Venezuela—142 pkgs. material, $539.

SOME C. & C. CONTRACTS.—The C. & C. Electric Company, of Garwood, N. J., whose New York offices are at 143 Liberty Street, reports recent receipt of a number of interesting contracts for both the foreign and domestic markets. Mr. C. R. Heap, of 47 Victoria Street, London, S. W., British agent of the C. & C. Company, has just sent over an order for five motors, varying from 4 hp to 20 hp each. The Seaboard Realty Company, of 127 West Forty-second Street, New York City, has ordered plants for three apartment hotels, which the concern is interested in up-town. The outfits consist of six 75-kw and two 60-kw generators for direct connection to 110-hp and 90-hp engines, respectively. The engines will be built by the Buffalo Forge Company, 39-41 Cortlandt Street. The Old Dominion Iron and Nail Works, of Richmond, Virginia, are to be installed with a 50-kw belted generator and nine motors varying in capacity from 6 to 25 hp each for machine shop use. The Gold Hill Copper Company, N. C., has requisitioned for a 50-kw generator, switchboard, and all-line material from the C. & C. people. The generator is to be direct connected to a 75-hp Harrisburg engine. This equipment is intended to be used for the Southern Company's smelting plant. A repeat order has been obtained from Moran Brothers, of Seattle, Wash., for four 20-hp vertical motors, for operating dry dock pumps. The Agnew Hotel, Atlantic City, will be equipped with a 50-kw C. & C. generator for lighting purposes. The Wheelwright Paper Company, of Wheelwright, Mass., has ordered a 125-hp generator and a 50-hp motor for power use. The Collins Manufacturing Company, of Philadelphia, has also ordered, for power purposes, two direct connected dynamos of 100-kw capacity each. A Durham, N. C., tobacco factory is to have 130 hp of motors. The Henriette Coal Mining Company, of Dunlo, Pa., has called for a 125-kw belted generator and switchboard, for lighting and running machinery at its mines. The new Astor Hotel, New York City, is to be furnished with a further lot of C. & C. equipment, six slow-speed, direct-connected motors, having just been ordered, for operating blowers. The motors will vary from 5 hp to 15 hp each. Further contracts now in hand include some 75 motors, varying from 5 hp to 50 hp each, for ventilating work, and about 10 dynamos for direct connection to gasolene engines, from 4 kw to 15 kw each.

SOME RECENT HARRISBURG ENGINE ORDERS.—The Harrisburg Foundry and Machine Works, 203 Broadway, report receipt of a number of engine orders within the last two weeks. Mayer & Flockhart, of Newark, N. J., have requisitioned for a Harrisburg standard engine of 150 hp for direct connection to a 100-kw generator, to be built by the Crocker-Wheeler Company. The outfit is to be used for power and lighting purposes in the New Jersey concern's foundry plant. Two 50-hp engines have been ordered for lighting use in the Soldiers' Home, Washington, D. C. The Sprague Electric Company is to furnish two 35-kw generators for direct connection to these engines. The Newport News Shipbuilding and Dry Dock Company has ordered three 40-hp Harrisburg engines for direct connection to General Electric motors. These outfits are intended to be installed for lighting work in the new Old Dominion steamship now building at the Virginia yards.

THE WARREN ELECTRIC COMPANY, of Sandusky, Ohio, is preparing to expand its business. The company has recently been reorganized, and E. P. Breckenridge, a wealthy Toledoan, has become interested. The new officers are C. C. Warren, president and treasurer; E. P. Breckenridge, vice-president; Frank Warren, secretary, and H. B. Warren, chief electrician and engineer. Extensive improvement will be made to the plant. Plans have been prepared for additions, and, with property recently purchased, the plant will have a total frontage of 621 feet and a depth of an entire block from north to south. An electric crane, capable of handling 30 tons, will cover the new building, which will be 165 feet in length, and used as machine shop. Considerable new machinery will be installed, and the power capacity will be increased. The improvements will cost about $100,000.

OVERHEAD EQUIPMENT FOR NEW ZEALAND.—The electrical engineering and contracting firm of J. G. White and Company, of 29 Broadway, New York City, is about to make shipment of a quantity of overhead equipment to New Zealand, for the city of Auckland electric traction system, the contract for the construction of which was recently secured by their foreign department in London. The material to be covered in the shipment referred to is being supplied principally by the Albert & J. M. Anderson Manufacturing Company, of Boston, Mass., and the Ohio Brass Company, of Mansfield, O.

THE CHICAGO CITY RAILWAY COMPANY has projected improvements involving an outlay of $8,000,000. They include new car shops and the remodeling of the power supply system. A new $3,000,000 power plant, having a capacity of 30,000 horse-power, will be located at Thirty-ninth and Halstead Streets; the entire South Side system will be supplied from this plant. The consolidation of the generating plants is to be supplemented with the substations, which are to be connected with the central power station by trunk lines.

THE HYATT ROLLER BEARING COMPANY, of Harrison, N. J., is having plans prepared for a modern shop, to be erected on the property adjoining its present plant. The building will be 50 x 200, two stories high. The demand for the Hyatt roller bearings has reached such proportions that the company has entirely outgrown its present facilities. Samuel M. Green, of Holyoke, is the architect. This new shop is but part of the improvements which are being contemplated in order to take care of increasing trade, at home and abroad.

CONDUIT FOR SPRINGFIELD, MASS.—Mr. Guy M. Gest, of Cincinnati and New York, has taken contracts at Springfield, Mass., for two conduit systems, one for the United Electric Light Company, and the other for the Springfield Street Railway Company, being a duplicate contract to that of last year. The railway conduit will contain the feeders for the overhead trolley. The order covers half a million feet of conduit construction.

BOOSTERS FOR BROOKLYN EDISON COMPANY.—The Brooklyn Edison Company has just placed a contract with the C. & C. Electric Company for the furnishing of three special boosters, to be installed in its three stations. Each booster is to be composed of three machines, one 150-hp motor for driving two 50-kw double commutator dynamos.

THE NEW JERSEY TRACTION COMPANY has placed a contract with the General Electric Company for three generators of 1,500-kw capacity each.

General News.

THE TELEPHONE.

SAN JACINTO, CALIF.—The Suburban telephone system, San Jacinto, will install 24 miles of extensions during the month of May.

SAN FRANCISCO, CALIF.—The Farallones Cable Company, which was recently incorporated in San Francisco with a capital stock of $75,000, expects to lay a submarine cable from a point near the Cliff house to the Farallon group of islands. The cable will be 28 miles in length and the shore line to the city will be about 8 miles in length. After considering the merits of a wireless telegraph system, it was decided to install a cable, costing $50,000. A bill is pending in Congress for the creation of a Farallon cable or for the promotion of such an enterprise started by private individuals. The company hopes to secure aid from this fund. The incorporators, including L. G. Boardman and James F. Swift, intend to begin work as soon as permission is obtained from Washington to establish a cable landing on the islands. In exchange the company will allow the Weather Bureau the use of its wires.

FARMER CITY, ILL.—The Gibson Telephone Company has begun the erection of a new brick exchange building.

CHICAGO, ILL.—The Chicago Telephone Company has prepared plans for a new exchange at Hyde Park, to cost about $25,000.

CHICAGO, ILL.—The Union Electric Telephone and Telegraph Company, Chicago, has increased its capital from $2,500 to $400,000.

ELGIN, ILL.—The Chicago Bell Telephone Company has recently moved into its new building in this city. The new plant has a present capacity of 1,100 subscribers, and cost $74,000, including a $25,000 switchboard.

GALESBURG, ILL.—The Galesburg Union Telephone Company proposes to increase its capital stock from $100,000 to $150,000 and will hold a meeting on May 20 for the purpose of voting on the proposition. The plant will be enlarged to about twice its present capacity, and the company also intends to extend its service.

NEW CASTLE, IND.—The New Castle Telephone Company is installing a system which is to be in operation by June 15. The plant will be operated in opposition to the Central Union Telephone Company.

BEDFORD, IND.—The Star-City Telephone Company is putting in a switchboard of the latest and most improved pattern, and will soon have its system in operation. The company will give free connection with all the independent lines in this (Lawrence) county.

INDIANAPOLIS, IND.—The Parker Telephone Company, of Parker, has increased its capital stock to $10,000. The Plainfield Telephone Company has increased its stock from $10,000 to $25,000. Both companies will make improvements and extend their service.

MULBERRY, IND.—The Peoples' Co-operative Telephone Company of this place is extending its lines in every direction. The demand for telephones among the farmers is far greater than the company can supply and lines cannot be extended fast enough to satisfy the people in the country who want telephones in their homes.

ROCKPORT, IND.—The bitter telephone war which has been waging between the Cumberland and Home Telephone companies for several weeks past has been stifled by a restrictive ordinance passed by the Council, providing that no electric, telephone, or telegraph company can place any poles or wires on the streets without first submitting specifications of the same to the Street Committee of Council. All controversies arising over the placing of poles or wires are to be referred to this committee.

INDIANAPOLIS, IND.—The Philadelphia Telephone Company, of Philadelphia, Ind., has filed articles of incorporation with the Secretary of State, with a capital stock of $3,000. The line will be operated through Hancock County. Clinton Parker, J. M. Duncan, J. M. Smith and Burt Cohee are the directors. The Modoc Telephone Company, with headquarters at Modoc, Ind., has been incorporated. Capital, $5000. Directors: Sylvester Willis, Peter Stepanak, R. H. Hunt, H. A. Gaddis and F. F. Whelan.

WASHINGTON, IND.—There is a war among telephone companies in this county for supremacy. For a number of years the Bell Company has been located at Washington, but has given poor service, and when an independent company proposed to put in a new line the proposition was accepted by the citizens. The new company intends to erect a system extending over the entire county. Consequently the old company immediately began the construction of county lines. The war has begun and the people are waiting for the rate-cutting, which is sure to come.

SHENANDOAH, IA.—An independent telephone system will be built here as soon as a franchise can be secured therefor.

DES MOINES, IA.—The Linden & Adel Telephone Company, capital $6,000, has been incorporated by H. Howell and others.

DES MOINES, IA.—The Colfax Telephone Company, with a capital stock of $10,000, has been incorporated here, with Henry Fellows and others as incorporators.

DES MOINES, IA.—The Midland Telephone Company, of Milford, has been incorporated with a capital of $25,000. P. Rasmussen, C. Torstenson, L. C. Fuller, H. S. Abbott, O. A. Hemphill, J. O. Stephenson, W. E. Hall, G. A. Paton, G. E. Blunt and J. T. Way are the incorporators.

DAVENPORT, IA.—The Iowa Telephone Company, at its annual meeting at Davenport, April 24, passed a resolution amending the articles of the incorporation of the company as follows: That the $1,275,000 of stock issued and outstanding of the company's $4,000,000 authorized capital should be common stock and that all stock issued in the future shall be preferred stock, drawing 5 per cent. annual interest. The acceptance of this rule is made optional with the present shareholders who may, if they wish, exchange their present stock for preferred stock. The change affects nearly $3,000,000 stock still to be issued. The following officers were elected: C. E. Yost, of Omaha, president; F. H. Griggs, vice president; J. B. Mason, secretary and treasurer, and E. B. Smith, general manager.

TOPEKA, KAN.—The Seneca County Telephone Company has increased its capital stock from $5,000 to $10,000.

JACKSON, MICH.—The Rollin Telephone Company will extend its line from Hudson to Jackson.

JACKSON, MICH.—The Peoples' Telephone Company has forfeited a check for $1,000, deposited with the city treasurer to insure the completion of the plant by March 31. Construction work has been held up through the financial difficulties of the Federal Telephone Company, which controls the plant.

JEFFERSON CITY, Mo.—The Southern Union Telephone Company of Illinois filed evidence of incorporation, with a capital of $10,000, of which $1,500 is to be used in Missouri, with office at Cape Girardeau.

CARTHAGE, MO.—The consolidation of the independent telephone companies of the mining cities of southwest Missouri was effected April 24. The formal transfer of stock was made to the New officers of the consolidated company. The new company is known as the Mineral Cities' Telephone Company and its capital is $300,000. The independent companies are those of Joplin and Carthage, Webb City and Centerville, Mo. J. W. Layne, of Carthage, is the promoter and president of the new company and the general offices will be in Joplin.

OMAHA, NEB.—The Henry County Telephone Company, of Mt. Pleasant, has increased its capital stock to $15,000.

BUFFALO, N. Y.—The Frontier Telephone Company will lay new telephone conduits. The contract involves an expenditure of about $400,000.

STATESVILLE, N. C.—The telephone company which is to build a line from Ronda to this place has been organized, with John Sowers, of Ronda, as president, and a capital of $1,000.

GRAFTON, N. D.—The Northwestern Telephone Company will build another line from Grafton to Langdon via Park River.

SULPHUR SPRING, OHIO.—A new telephone exchange is to be established here.

WAUSEON, OHIO.—The Northwestern Ohio Telephone Company is constructing a line to Pettisville.

WAKEMAN, OHIO.—The Wakeman Mutual Telephone Company has been incorporated, with a capital of $6,000.

ELYRIA, OHIO.—The Elyria Southern Telephone and Toll Company has increased its capital stock from $20,000 to $40,000.

ADA, OHIO.—The Ada Telephone Exchange has increased its capital stock from $30,000 to $75,000. Improvements will be made.

HASKINS, OHIO.—The Haskins Mutual Telephone Company has been incorporated, with $10,500 capital stock, to build a local system.

COLUMBUS, OHIO.—The Collinwood Home Telephone Company, of Collinwood, has increased its capital stock from $30,000 to $40,000.

WILSHIRE, OHIO.—The Citizens' Telephone Company, of Wilshire, is building lines to Steele and Wilshire, connecting up a large number of farmers.

CINCINNATI, OHIO.—The Cincinnati Telephone Company, a Kentucky corporation, has been authorized to do business in Ohio, with headquarters in this city.

WOOSTER, OHIO.—The local telephone exchange is to be greatly improved. New cables are to be put up and the common battery system is to be installed in the exchange.

WASHINGTON, C. H., OHIO.—The Citizens' Telephone Company is enjoying rapid growth. It has placed 366 telephones during the past year, a gain of over 50 per cent.

COLUMBUS, OHIO.—The Manchester Telephone Company has been incorporated with $1,500 capital to construct telephones in Manchester and through Adams and Brown counties.

MANSFIELD, OHIO.—The Star Telephone Company is building lines to Pleasant Valley and Germany, connecting up a number of farmers in these districts. The company has 600 telephones in Mansfield.

TOLEDO, OHIO.—All the necessary material to complete the plant of the Toledo Home Telephone Company is in the city, and the construction work is being pushed rapidly. It is expected the system will be ready not later than June 1.

DELAWARE, OHIO.—The Delaware Citizens' Telephone Company has placed a contract with the Stromberg-Carlson Telephone Company for a new improved multiple central-energy switchboard of 1,800 lines capacity. The company now has 960 telephones in operation and is growing rapidly.

TOLEDO, OHIO.—Representatives of the Putnam County Telephone Company, the Northwestern Telephone Company and the Napoleon Home Telephone Company held a conference with representatives of the Toledo Home Telephone Company a few days ago, relative to toll line and farmer line rates.

DAYTON, OHIO.—The Dayton Home Telephone Company, recently sold by the Federal Telephone Company, is now in the hands of Dayton and Columbus people. Work on the conduit system is to be pushed at once and an exchange building is to be erected at Fourth and Jefferson streets. The company has over 4,000 contracts for telephones.

BELLEVUE, OHIO.—The Bellevue Home Telephone Company has elected directors as follows: H. C. Stall, B. F. Bell, W. M. Halliday, F. A. Knapp, D. Calhoun and C. R. Callighan. F. A. Knapp was elected secretary and W. M. Halliday, treasurer. The company has 410 telephones in operation and made a a net gain of 40 telephones during the year.

LORAIN, OHIO.—Directors of the Black River Telephone Company met a few days ago and decided to double the capital stock of the company and to increase the capacity of the exchange to 1,000 lines. A new building will be erected and a common battery system installed. Considerable quantities of poles, cables, copper wire and batteries will be purchased. A. W. Hoge, consulting engineer, has charge of the work.

NORWALK, OHIO.—The Huron County Telephone Company is making numerous improvements to its property. It has about 800 telephones in operation and numerous country extensions have been projected which will increase the list of farmer subscribers. A new line will be built from New Washington to Sulphur Springs, giving direct connection with Bucyrus. The earnings of this property have increased rapidly and a recent proposition to sell has been turned down by the present owners.

NORWALK, OHIO.—The Norwalk Telephone Company has just been reorganized with a large amount of new capital. The work of rebuilding the line is being pushed vigorously. All new poles are being set, new wires strung, and it is to be a new plant all through. It is to be a full metallic circuit, all copper wires, on the central energy system. The Bell Company, a few weeks ago, doubled its rates, but now it is seeking to regain many of its old customers. The Norwalk Company will maintain the old rate of $1 a month for houses and $2 a month for business places.

BAKER CITY, ORE.—A new telephone line between this city and the Virtue Mining District has just been completed. Gradually the telephone company is connecting all of the important mining camps of Eastern Oregon with the central office in this city. Several more lines will be constructed this year.

PHILADELPHIA, PA.—The Delaware and Atlantic Telegraph and Telephone Company has decided to construct an underground conduit from Philadelphia to Wilmington, which will pass through all the boroughs along the line of the Chester pike.

NASHVILLE, TENN.—The Jackson Home Telephone Company, of Madison County, capital stock $110,000, nas been incorporated by James L. Dunn, James D. Lloyd, R. F. Spragins, J. H. Hoffman and W. D. Nelson.

SHIRO, TEX.—The Shiro Telephone company will extend its line to Loma.

SALT LAKE CITY, UTAH.—The Rocky Mountain Bell Telephone Company is installing an exchange at Lander, Wyo., and will at once start building north to Thermopolis and into the Big Horn country.

SALT LAKE CITY, UTAH.—The Rocky Mountain Bell Telephone Company has doubled the Ogden exchange in the past six months and has just added another section to the local switchboard, capable of handling 800 new subscribers.

RICHMOND, VA.—The Goochland Telephone Company has been organized with a minimum capital of $500 and a maximum of $5,000. H. D. Leake was elected president; C. H. Powell, secretary; Dr. W. M. Holman, treasurer, and R. H. Monteiro, general manager.

BANGOR, WIS.—Bangor Telephone Company has incorporated, with a capital stock of $5,000.

LA CROSSE, WIS.—The Interstate Telephone Company has increased its capital stock from $100,000 to $150,000.

OSSEO, WIS.—The Osseo Telephone Company has decided to issue bonds for $8,000 to build new lines to Fairchild, Fall Creek, etc.

McFARLAND, WIS.—The McFarland Telephone Company, capital, $2,500, has been incorporated by E. N. Edwards, M. D. Larson and others.

CHEYENNE, WYO.—The citizens threaten to organize an independent home telephone company unless the Rocky Mountain Bell Telephone Company reduces the rates for telephones in and around Cheyenne.

ELECTRIC LIGHT AND POWER.

MONTGOMERY, ALA.—The city of Montgomery has contracted with the Montgomery Light and Power Company for 242 arc lights for ten years at $51 per light per year. This is is said to be the lowest price for similar service in the United States. This low rate is due to power being generated by water power at Tallassee Falls, 35 miles away. Electric power for manufacturing purposes is to be offered at prices lower than steam plants can produce it.

SAN FRANCISCO, CALIF.—The Santa Fe Pacific Railroad has made an appropriation for improvements at the shops in Needles, Calif., and will install an electric lighting plant.

SAN FRANCISCO, CALIF.—The General Electric Company through its Salt Lake City agency recently closed a contract with the United States Mining Company for two additional electric locomotives. The company now has in use an electric haulage system with three electric locomotives.

SAN FRANCISCO, CALIF.—The City Council of Chehalis, Wash., will take action on an ordinance recently introduced granting the Snoqualmie Falls Power Company a franchise for an electric power line. Chehalis is on the line of the company's proposed extension from Puget Sound to Portland, Ore.

SAN FRANCISCO, CALIF.—The United Gas and Electric Company, which was recently incorporated in San Francisco by C. E. Green, W. Gregg, jr., C. O. Poole, J. E. Green and C. H. Pennoyer, has a capital stock of $2,500,000. Several of the incorporators are also connected with the Consolidated Light and Power Company, which is in close relations with the Standard Electric Compan. The United Gas and Electric Company will take the place of the Consolidated Company as the distributor of the Standard Electric Company's current in the counties south of San Francisco. It has also arranged to purchase the Electric Improvement Company of San Jose and the San Jose Light and Power Company. The electric lighting machinery of these two companies and of the Consolidated Company will be placed under one roof. The system will be extended wherever there is a demand for elctric light and power and gas.

HARTFORD, CONN.—The woolen mills at Buckland of the E. E. Hilliard Company are now operated by electric power generated at the Hockanum River water-power plant, which was bought by the Hilliard Company several months ago. Power is transmitted a third of a mile to the Hilliard mills. Besides the power used in the mills, there is a surplus sufficient to light the buildings. The plant is designed to provide for a change from electric power to steam on short notice.

CHICAGO, ILL.—The United Water and Light Company of Chicago, has been incorporated. Capital stock, $200,000. Incorporators: Waldo F. Tobey, Gail Dray and George C. Madison.

EDWARDSVILLE, ILL.—At a special meeting of the City Council a franchise was granted for furnishing electric lights and power for public and private use, for a term of fifteen years to J. R. Bennet, of Wyandotte, Mich. The franchise provides for 50 street arc lights for the city at a rate of $69 per year each. The franchise held by the Edwardsville Electric Light and Power Company expires October 14 of the present year.

ST. CHARLES, MO.—T. W. Crouch and other capitalists of St. Louis, have bought for $100,000 the St. Charles electric plant, which supplies both light and power. It is the intention of the new owners to enlarge the plant considerably and to widen the scope of its operations. Those interested with Mr. Crouch are F. W. Child, Paul A. Furz, Edgar A. Tilton and Edward S. Lewis.

CANTON, MO.—The Canton Electric Light Company has asked an injunction to prevent the town of Canton from building and operating an electric light plant, on the ground that this is not one of the functions of the municipality. The town recently made arrangements to furnish itself and its citizens with light and the old company seeks to prevent the consummation of these plans. The case has been submitted on briefs in the United States District Court in St. Louis.

LEBANON, OHIO.—The recent election resulted in favor of an issue of $6,000 electric light bonds.

LA RUE, OHIO.—A proposition to issue bonds for the purpose of building a municipal lighting plant has been voted down.

CANTON, OHIO.—The Canton Light, Heat and Power Company is installing a new electric coal conveyor system in its power house.

LOVELAND, OHIO.—Gen. T. T. Heath, of this place, is organizing a company with $100,000 capital stock to erect an electric light and water works plant.

BRADNER, OHIO.—The village of Bradner is securing estimates on the cost of a municipal lighting and water works plant. This is the second time bids have been called for.

ZANESVILLE, OHIO.—The Citizens' Electric Light Company, which has secured a franchise for an electric lighting and hot water heating system, is preparing plans for its new plant. It is probable that water power will be used. William Scott, of Chicago, and C. G. Griffiths, of Zanesville, are the chief promoters.

COLUMBUS, OHIO.—The East Columbus Heat and Light Company has applied to the city for a franchise to furnish heat, light and power, steam and hot water in a certain district in this city. Electricity for lighting is to be furnished at 15 cents per kilowatt for 12½ years, with discounts for cash from 10 per cent. on $20 or less to 40 per cent. on bills of over $100. For power the rate is to be 7½ cents per kilowatt. After 15 years the city is to have the option of acquiring the plant at a price set by arbitrators.

ALTOONA, PA.—The Citizens' Electric Light Company, with a capital of $150,000, has been organized here. S. S. Reighard is president of the new concern.

MONTREAL, QUE.—The first cement plant in Canada to be operated by electric power is that of the National Portland Cement Company at Durham, Ont. All of the cement-making machinery in this plant will be driven by induction motors supplied with current by two Westinghouse 450-kw three-phase alternators. The Westinghouse Company also furnishes the 8-panel switchboard and instruments.

SALT LAKE CITY, UTAH.—Active work is now under way for securing more water power at the falls near Spokane, Wash., to be used in operating the mines at the Cœur d'Alene.

SALT LAKE CITY, UTAH.—A Chicago company will build a large power plant on the Shoshone Falls of the Snake River in Idaho. Power will be transmitted over a radius of 100 miles.

SALT LAKE CITY, UTAH.—The county commissioners of Ada County, Idaho, have granted a franchise to The Electric Power Company, Limited, for the erection and maintenance of a pole line throughout the highways of the county. The franchise runs for 50 years.

SALT LAKE CITY, UTAH.—The Cascade Electric Company, of Idaho Springs, Colo., will immediately double the capacity of the transmission line from Georgetown to Idaho Springs, and in addition will build its lines into Gilpin County for the purpose of furnishing power to the mines in that section.

SALT LAKE CITY, UTAH.—A. H. Tarbertt, of Salt Lake City, has entered into contract with the Westinghouse Electric and Manufacturing Company for the construction at American Falls, Idaho, of an electric plant to develop 3,000-hp, to be utilized for lighting the city of Pocatello, and to furnish power for the operation of the Union Pacific shops. A contract has already been entered into between the railroad company and Mr. Tarbertt.

SALT LAKE CITY, UTAH.—A company, headed by F. J. Bridge, vice president of the American Falls Water Power, Light and Irrigation Company, with a capital of $300,000, proposes to erect a power and pumping plant at American Falls. With the power thus obtained water will be pumped to an

elevation which will enable the irrigation of a vast tract of land situated in the Fort Hall reservation, Idaho. Nearly all the members of the company are from Joliet, Ill.

SALT LAKE CITY, UTAH.—The Mitchell-Copeland Power Company, recently incorporated in Los Angeles, Calif., will erect a large power plant at Butte, Mont., using the waste heat of discarded slag from the smelters. By the power thus derived the company will operate the street railway and lighting systems of the city. It is estimated that the smelters at Jerome, Ariz., handle more than 900 tons of ore a day, throwing away about 600 tons of slag every twenty-four hours. It is claimed that from the discarded slag one and one-half pounds is equal to a pound of coal for the purpose of generating power. Mr. Mitchell has made an offer, which has been accepted, to work the slag at Butte, where he will furnish the copper plant with free power, and with the surplus he will light the city and operate the street railway system.

YAKIMA, WASH.—The Yakima Water, Light and Power Company will install an additional generator in North Yakima, and will extend the electric system.

WAUKESHA, WIS.—The city has awarded a 25-year franchise to the Waukesha Electric Light Company for street lighting.

THE ELECTRIC RAILWAY.

BANGOR, ME.—The Hancock County Railroad Company has purchased water powers on Union River to the value of $30,000 for the purpose of generating electric power for a trolley line, to connect the principal towns of Hancock County. The railroad company announces its intention to expend $300,000 on its system, in addition to the $30,000 paid for water powers and the expense of building a dam.

MUSKEGON, MICH.—An electric railway from Manistee to Muskegon is being promoted by L. S. Mace, J. S. Huey and R. H. Lanyon, of Chicago.

DETROIT, MICH.—Motormen and conductors on the lines of the Detroit United Railways are endeavoring to secure an increase in pay of from 20 to 25 cents per hour.

JACKSON, MICH.—The Detroit, Ypsilanti, Ann Arbor and Jackson Railway has been opened to Jackson. The first car made the run from Detroit to Jackson in 3 hours 45 minutes.

HOLLAND, MICH.—The Grand Rapids, Holland and Lake Michigan Railway has reduced the fare between Grand Rapids and Holland from 90 to 70 cents round trip, to meet the competition of the steam road. Two new generators have been installed in the station at Jenison which will permit of the operation of twice as many cars as at present.

KALAMAZOO, MICH.—When the interurban line was in process of construction between Kalamazoo and Battle Creek the farmers protested vigorously against the line, claiming it would injure farm values. Instead of having been a detriment the road has increased the price of land enormously. For a distance of eight miles out of Kalamazoo land is now held at $150 per acre, while equally as good land at the same distance from the city, but away from the electric line, can be purchased at $75 per acre.

NASHUA, N. H.—Articles of incorporation have been filed for the Nashua and Pepperell Street Railway Company, with a capital stock of $50,000. The directors are Wallace D. Lovell, Newton, Mass.; Edmund B. Fuller, Haverhill, Mass.; G. F. Marshall, Malden, Mass., and A. W. Dean, H. G. Holden, J. L. H. Marshall and O. B. Tilton, all of Nashua.

SYRACUSE, N. Y.—The new trolley road from Syracuse to the Indian Reservation has been completed, and cars are now running.

TROY, N. Y.—A new electric railway from this city to Williamstown, Mass., is to be built this summer. It will be 50 miles in length. George E. Greens, of Hoosic Falls, is president of the company that will build the road.

GUTHRIE, OKLA.—A charter has been issued to the Topeka, Lawrence & Kansas City Electric Railway Company for 20 years to establish a railway between Topeka, Kan., to Kansas City, Kan., and Kansas City, Mo., via Lawrence, Kan., the estimated length of the road being 75 miles. The capital stock is $2,000,000 and the principal offices are to be at Lawrence, Kan., and Oklahoma City, O. T. The officers of the company are J. B. Adams, H. M. Levan, R. Levan, T. S. Salathiel, Independence, Kan., and M. L. Adams and E. R. Salathiel, of Oklahoma City.

AKRON, OHIO.—The Northern Ohio Traction Company has announced a voluntary increase of wages on its surburban roads.

MANSFIELD, OHIO.—The Citizens' Railway, Light and Power Company, which owns the Shelby-Mansfield road, is planning to extend the line to Plymouth.

TIFFIN, OHIO.—The James G. Corcoran Company, of Pittsburg, has the contract for building and equipping the line of the Tiffin and Southern Railway Company.

TOLEDO, OHIO.—The Toledo, Bowling Green and Southern Railway is now operating cars through Toledo to Findlay, the connecting link having been completed.

CINCINNATI, OHIO.—The Cincinnati, Newport and Covington Street Railway Company contemplates extending the Ft. Thomas line to Cold Springs, Ky.

EAST LIVERPOOL, OHIO.—J. N. Taylor is president and W. L. Smith secretary of a company formed by local people to build an electric railway from Canton to East Liverpool.

WARREN, OHIO.—The Trumbull County commissioners have granted a 35-year franchise through the county to the Conneaut and Southern Railway, which proposes to build from Conneaut to Youngstown.

LIMA, OHIO.—Seven additional miles of the Western Ohio Railway were placed in operation April 23. Cars are now in regular operation from Lima to New Bremen. The Minister extension will be opened in a short time.

SPRINGFIELD, OHIO.—The county commissioners have granted a 25-year franchise to the Springfield and Washington C. H. Traction Company permitting it to cross county roads. L. B. Corry, Dr. Gotwald and others, of Springfield, are promoters.

CLEVELAND, OHIO.—John Hoefgen, promoter of the People's Street Railway Company, popularly known as the three-cent-fare road, has deposited a certified bond for $25,000 with the city auditor to insure the building of the roads, in compliance with the terms of the ordinance.

CLEVELAND, OHIO.—The Canton Bridge Company is erecting a 400-foot bridge across the Vermillion River, on the line of the Cleveland, Elyria & Western Railway. When this is completed, about six weeks hence, the Norwalk extension of the road will be opened for traffic.

IRONTON, OHIO.—The Ohio Valley Traction Company has been incorporated, with $100,000 capital stock, by Levi D. York, Raymond D. York, Samuel P. Baird, John H. Lange and Henry W. Miller. The same parties are interested in the Portsmouth Street Railway.

STEUBENVILLE, OHIO.—The Steubenville, Mingo and Ohio Valley Traction Company is surveying and grading for its extension from Brilliant to Martin's Ferry and Wheeling. Manager Flynn states that power equipment for the new station has been contracted for and that a site will be purchased at once.

CLEVELAND, OHIO.—General Manager Andrews, of the Eastern Ohio Traction Company, is securing estimates on a storage battery plant of 400-ampere-hours capacity for the power station at Gates Mills. The company has two large storage battery stations on its Chagrin Falls division which are giving satisfactory results.

NEW CARLISLE, OHIO.—The Village Council has passed a resolution instructing that suit be brought against the Dayton, Springfield and Urbana Railway for the purpose of damages and to eject the road from the streets of the corporation of New Carlisle. This portion of the road is known as the Springfield and Western Railway.

CLEVELAND, OHIO.—The Callinan Construction Company has placed a contract with the Carnegie Company for twenty miles of 75-pound T-rails for the Indianapolis, Greenwood and Shelbyville Railway. It was originally intended to lay 60-pound rails, but these could not be obtained for nine months, whereas the manufacturers agree to deliver the heavier rails within three months.

CINCINNATI, OHIO.—The Newport & Alexandria Traction Company has received estimates on the cost of building the road. Double-track line from Newport to Fort Thomas and single track the balance of the distance will cost $390,000, and the average grade will be about 2½ per cent. The power house will be erected near Newport and the company will enter the lighting field in that place.

FINDLAY, OHIO.—The promoters of the Findlay and Marion Railway Company claim to have completed negotiations in New York for the financing of their project. A 30-foot private right of way has been obtained from Marion to Findlay, with a branch from Carey to Fostoria, a total of 62 miles. The road will be a connecting link between Toledo and Columbus and it will cost about $1,500,000 to build. It is stated that work will commence at once.

STEUBENVILLE, OHIO.—The Steubenville Traction and Light Company has elected officers as follows: M. W. Stround, president and treasurer; W. McMiller, secretary and attorney, and J. R. Ross, superintendent. Directors: Morris W. Stround and John C. Lowrey, Philadelphia; R. G. Richards, J. C. Ross and M. McD. Miller, of Steubenville. The company is making extensive improvements to its road and will shortly be operating cars to Toronto.

TOLEDO, OHIO.—The Toledo, Columbus, Springfield and Cincinnati Railway Company has adopted a unique plan of selling its stock and at the same time popularizing the road by making as many people as possible interested in its early construction and operation, to the end that it may prove a financial success. The plan is to sell applicants for positions a share of stock for $10 and then place their applications on file, assuring them the preference for appointment when the road is ready to operate. The company is building from Lima to Bellefontaine and hopes to extend to both Toledo and Columbus.

NEW INDUSTRIAL COMPANIES.

THE CHIPMAN ELECTRIC PURIFYING COMPANY, of New York, has been incorporated; capital, $200,000. Directors: J. R. Davies, Brooklyn; W. R. Chipman and I. E. Doying, New York.

THE MAGNETO-ELECTRIC PURE WATER COMPANY, of Greater New York, has been incorporated; capital, $1,000,000. Directors: John T. Harris, George S. Bixby and Horatio S. Burne, of New York, and Smith M. Weed, of Plattsburg, N. Y.

THE AMERICAN ELECTRIC ALARM COMPANY has been incorporated in Jersey City, N. J., to manufacture electric alarm devices; capital, $500,000. Incorporators: L. B. Dailey, H. O. Coughlin, Paul Tissen, Aug. S. Meeker and K. K. McLaren.

OBITUARY.

MR. J. H. CASSIDY.—John H. Cassidy, the manufacturer of electric and gas fixtures, died at his home, West Orange, N. J., on May 3, of old age. He was 82 years old and was one of the oldest established dealers in his line in New York. His widow, who was a Miss Deborah Jones, of Philadelphia; a daughter, Mrs J. B. McCoy, of South Orange, and a son, J. C. Cassidy, of East Orange, survive him.

PERSONAL.

MR. M. K. EYRE, on May 1, assumed entire charge of the selling organization of the Buckeye Electric Company.

MR. J. C. CHAMBERLAIN has resigned as vice president and general manager of the Electric Launch Company of Bayonne, N. J.

MR. H. H. GEARY has been put in entire charge of the selling organization of the Fostoria Incandescent Lamp Company, of Cleveland, Ohio.

MR. C. A. COFFIN, president of the General Electric Company, has been elected a member of the New York Chamber of Commerce.

MR. W. DULLES, JR., has just been elected to the presidency of the American Stoker Company and as a resident member of the New York Chamber of Commerce.

MR. W. C. HUMSTONE, the well-known superintendent of the Metropolitan Division of the Western Union Telegraph Company, has resigned from that position.

MR. H. R. SUTPHEN has been appointed general manager of the Electric Launch Company of Bayonne, N. J., and is now actively directing affairs at the yards on the Passaic.

MR. W. B. JACKSON, traveling engineer for the Stanley Electric Manufacturing Company, has sailed this week on the "Kronprinz Wilhelm" for an extended European trip.

PROF. W. E. GOLDSBOROUGH, chief of the department of electricity at the St. Louis World's Fair, has just issued his first circular to the electrical industry in regard to that subject.

MAJ. G. W. FOSTER.—Under the recent reorganization of the Southwestern Telephone and Telegraph Company, Maj. George W. Foster, formerly of Toledo, has received the appointment of assistant general manager, with headquarters in Dallas, Texas.

MR. FREDERICK DARLINGTON, who is connected with the Stanley interests at Great Barrington, Mass., goes abroad this week, accompanied by Mrs. Darlington, on board the North German Lloyd "Kronprinz Wilhelm" for a brief vacation in Europe.

MR. M. C. RYPINSKI, who for the last five years has been associated with Mr. L. T. Robinson in the General Electric Laboratory at Schenectady, N. Y., has severed that connection in order to take charge of the factory of the Empire Electrical Instrument Company, in New York City.

MR. FRANK S. GORTON, secretary and treasurer of the Chicago Edison Company and one of that company's original organizers, has resigned and will retire from business on May 1. After a trip to Europe he will return to Chicago to devote his attention to his personal interests.

MR. REGINALD J. WALLIS-JONES, of the English firm of Wallis-Jones & Dent, is now visiting this country and is making a tour of inspection, etc., in regard to electrical matters. He has had a long connection with electric lighting and other work, and is in close touch with all the later developments.

MR. ARTHUR D. WHEELER.—At the meeting of the directors of the Central Union Telephone Company, in Chicago, Mr. Arthur D. Wheeler was elected first vice president in place of Col. R. C. Clowry, who has recently removed to New York as president of the Western Union Telegraph Company.

MR. CESARE PIO, a well-known contributor to the columns of the ELECTRICAL WORLD AND ENGINEER, has recently made a tour of the world for pleasure and to investigate electrical conditions, and at the present time is connected with the Electric Construction Company, of Wolverhampton, one of the leading concerns in the field in England.

DR. H. MORTON.—Marked improvement is reported in the condition of President Henry Morton, of the Stevens Institute of Technology, at his home in Hoboken, N. J. President Morton underwent a surgical operation on April 15 last, but recently suffered a relapse. The doctors in attendance are very much encouraged and expect his recovery.

MR. C. L. ETHERIDGE, for some years assistant chief engineer of the Chicago Telephone Company and recently western agent of the Evans-Almirall hot-water heating system, has been recently appointed chief electrical engineer of the Pullman Company, to take the place of Mr. D. Avery Kimbark, who recently left to go into business for himself.

MESSRS. A. C. PAIN, of Belliss & Morcom, Ltd., the high-speed engine builders of Birmingham, England, and T. H. Parrott, of Edgbarton, the general manager, are now visiting this country, studying the application of steam and other engines in electric light and electric railway work, and inspecting machine tools, etc. They will be about a month in the United States.

MR. W. M. McFARLAND, acting vice president of the Westinghouse Electric and Manufacturing Company, will deliver a lecture on "Electric Power Distribution in Manufacturing" at Cornell University, on Friday, May 9. The several different systems of distribution and their relative advantages will be discussed and the manner of applying electric motors to machinery will be illustrated by a large collection of stereopticon views.

MR. JAMES F. CUMMINGS, manager of the British electrical engineering and contracting firm of Maguire & Baucus, London, which concern represents the British interests of the European Maguire Manufacturing Company, Limited, the Aultman & Taylor Machinery Company, of Mansfield, Ohio, builders of the Cahall boilers, and other American manufacturing concerns, is now on a visit to the United States. He is a guest at the Hotel Imperial, Broadway and Thirty-second street, New York.

MR. N. M. GARLAND, formerly representative in the northeastern states of the Emerson Electric Manufacturing Company, of St. Louis, Mo., who is well and favorably known among the electrical fraternity in that section, will, after May 1, assume the management and control of the New York office of the Ohio Brass Company, of Mansfield. This appointment has been made owing to the fact that Mr. Alfred B. Edes, formerly manager of this office, has been appointed sales manager of the company, and will hereafter be located at the main offices at Mansfield.

MR. E. M. MULFORD, JR.—It is announced from Chicago that Mr. Edward M. Mulford, Jr., manager of the Chicago office of the Western Union Telegraph Company, has been promoted to be manager of the New York office and has left there to assume his new duties. J. C. Smith, manager of the Galveston, Texas. office, has been appointed to succeed him. taking charge May 13. Mr. Mulford has been in the service of the Western Union for the past eighteen years. At various times he served as manager at Camden, N. J., Philadelphia, and Champaign, Ill. In 1899 he entered the Chicago office as clerk and stenographer and was steadily promoted. He was born at Greenwich, N. J., January, 1865.

MR. C. VANDERBILT.—A telegram from Albany states that Mr. Cornelius Vanderbilt, as the representative of the New York Central Railroad, has been in consultation with the officials of the General Electric Company at Schenectady as to the possibility of substituting electricity for steam on the entire system. Mr. Vanderbilt spent several hours at Schenectady discussing the problem, and it is said has concluded to advise the change. The General Electric people were asked by Mr. Vanderbilt what the maximum expense would be to change the motive power on the New York Central system, and the figure given, although kept a secret, is said to have surprised Mr. Vanderbilt because of its lowness. It was suggested at the conference that sufficient electric power to propel all trains on the New York Central could be supplied from Niagara Falls.

MR. AND MRS. C. ODILON MAILLOUX, of No. 48 West Seventy-third street, New York City, entertained with an elaborate dinner on Sunday evening a number of guests in honor of M. Maurice Leblanc, of Paris, the well-known electrical engineer, who is about to return to France. Among those present on this pleasant occasion were M. de Laval, of Pittsburg; Mr. Carl Hering, past president of the American Institute of Electrical Engineers; Dr. M. I. Pupin, of Columbia College; Mr. William C. Gotshall, president New York & Port Chester Railroad Company; Mr. Ralph D. Mershon, electrical engineer of Montreal and New York; Dr. Ralcy Husted Bell, the well-known litterateur; Dr. Samuel Sheldon, of the Brooklyn Polytechnic; Mr. John W. Lieb, general manager New York Edison Company, and Mr. Gano S. Dunn, electrical engineer of the Crocker-Wheeler Company.

MR. PAUL M. LINCOLN.—The announcement that Mr. Paul M. Lincoln has resigned his position as resident electrician for The Niagara Falls Power Company will come as a surprise to many of his friends and acquaintances. Mr. Lincoln entered into the work of installing the dynamos at the power-house at Niagara Falls in February, 1895, and carried through most successfully the entire installation of the electrical equipment. Many new problems were necessarily met in this, the first plant of its kind, and each was successfully solved; and that the operation of the power-house has been so satisfactory thus far is largely due to Mr. Lincoln's ability. Mr. Lincoln is a member of the American Institute of Electrical Engineers, the American Electro-Chemical Society, and other like organizations. Recent attention has been called to his work because of several important devices which have been patented by him, one of the most widely known being the Lincoln synchronizer, which has been fully described in these columns. He leaves to accept a position with the Westinghouse Company, of Pittsburg, Pa.

MR. B. BROOKS.—The New York Press has the following breezy item: American District Telegraph seems to have found sudden favor in Wall Street, owing, no doubt, to the new blood from Denver and Chicago. Belvidere Brooks—odd name, isn't it? Belvidere means "fine prospect," and that is what Brooks, of Denver, presents when in action. This new general superintendent of the Western Union and A. D. T. is more of a Texan than President James Stillman, of the City National Bank, for he was both born and raised in the "Lone Star" State, whereas Mr. Stillman merely happened to be born there en passant. Mr. Brooks is nearly 43 years old. He started at the bottom as a messenger at Navasota, Tex., in 1871, and in six years was an operator, train dispatcher, etc., of the Houston & Texas Central Railroad. In 1879 he was manager of the Western Union office at Navasota, subsequently taking charge of offices at Waco, El Paso and Galveston. In 1890 he was manager at Denver, and in 1893 assistant superintendent. To-day—general superintendent in New York. Notwithstanding his unusual abilities, he is said to be immensely popular with his men.

EDUCATIONAL.

LEHIGH UNIVERSITY.—The Register of Lehigh University, South Bethlehem, Pa., just issued, shows the attendance of 554 students, from 26 States and 9 foreign countries. There are 49 in the teaching staff. Eleven courses of instruction are offered at the University: The classical course, the Latin-scientific course, the courses in civil engineering, mechanical engineering, metallurgical engineering, electrical engineering, mining engineering, analytical chemistry, geology, physics and electrometallurgy. A list of the graduates of the University, 1,203 in number, during the 36 years of its existence indicates that this institution is exerting a very marked influence on the industrial development of the United States, and also of foreign countries.The following scholarships will be open to competition at the annual examinations in June: Two in the classical course of $150 and $100 each. One in the Latin-scientific course of $125. Five in the following courses: Civil engineering, mechanical engineering, electrical engineering, mining and metallurgical engineering, and chemistry, of $150 each. Provision is made for worthy and needy students whereby they may postpone payment of tuition until after graduation.

Trade Notes.

REMOVAL.—Mr. A. O. Schoonmaker, the mica dealer, has removed his place of business from 158 William street to 221 Fulton street, New York.

THE SHELBY ELECTRIC COMPANY, Shelby, Ohio, is planning to make important additions and improvements, which will greatly increase its output of lamps.

MR. J. S. FISH, manager of the Shelby Electric Company, has just returned from an 8,000-mile trip through the country, calling on the larger class of lamp trade.

THE MOLONEY ELECTRIC COMPANY, of St. Louis, has opened a Chicago office at 408 Stock Exchange Building. Walter Krausnick will look after the Chicago territory.

THE CONLEY ELECTRIC FURNACE.—We have received an inquiry for the address of the Conley Electric Furnace Company, of New York, which controls the electric furnace described and illustrated in our issue of April 26.

THE BURT MANUFACTURING COMPANY, of Akron, Ohio, recently made an important shipment of its Cross oil filters to different cities in India, China, Japan and other countries of the Far East. The sale of its products has extended to 28 different countries.

THE BUCKEYE ELECTRIC COMPANY, Cleveland, Ohio, has recently added very materially to its equipment and has also enlarged its plant. Its present output is 10,000 lamps per day, which has been rendered necessary by the increasing demand for Buckeye lamps.

THOMPSON, SON & CO. have removed from 107 Liberty street, New York, into a suite in the new Engineering Building, 114 Liberty street. Their new storeroom and factory are now located at 90 Verona street, Brooklyn, and are equipped with all the latest improved machinery and appliances.

JENNEY ELECTRIC MANUFACTURING COMPANY, Indianapolis, Ind., has just issued a letter to linotype users, calling attention to the fact that it has recently supplied the *Chicago Tribune* with 43 of its motors for linotpye work, and has also equipped a number of other newspaper plants.

PORTABLE FORGES.—The Buffalo Forge Company, in a 48-page pamphlet, describes and illustrates a long line of portable forges, almost 30 types being shown in excellent engravings. Lines of hand-blowers, blacksmith's drills, punches, shears and other blacksmith's tools are also shown.

VALVES AND FITTINGS.—The Crane Company, Chicago, Ill., has issued a 96-page catalogue devoted entirely to extra-heavy valves, fittings and pipework for extreme pressures. All the pipes and fittings listed are tested at 800 lbs. pressure to the square inch, and are suitable for a steam pressure of 250 lbs. to the square inch.

THE DRIVER-HARRIS WIRE COMPANY has moved from Newark, N. J., to Railroad avenue, Harrison, N. J., across the river from Newark. It has a new building and much better facilities for the production of its various lines of wire. This company, as is well known, manufactures Climax resistance wires and fine wires in all metals.

THE FOSTORIA INCANDESCENT LAMP COMPANY, Cleveland, Ohio, (lamp and glass works, Fostoria, Ohio,) reports that it is now manufacturing 61 different styles of inner globes. It is its intention to manufacture every style of globe for which there is any demand whatever, in an effort to make good its claim that it is headquarters in this line.

EMERSON FANS.—The Emerson Electric Manufacturing Company, St. Louis, is sending to its patrons a postal card bringing to mind the approach of the fan season. An illustration shows a portly gentleman as he would appear on a hot day were he deprived of the services of an electric fan. But little text is required to supplement the telling illustration.

THE "LONG-ARM" SYSTEM COMPANY, Cleveland, Ohio, very completely describes and illustrates the "long-arm" power doors for use on steamship bulkheads. The doors are operated pneumatically, the pump for compressing, storing and regulating the delivery pressure of the air to the system being driven either by electric motor or direct by steam.

ELEVATORS.—The Eaton & Prince Co., Chicago, Ill., in a 32-page catalogue gives a large number of illustrations with accompanying descriptions, of the many types of elevators of its manufacture. Among those are a number of electric elevators, passenger and freight, both direct-coonnected and belted. One of these types is for a speed up to 300 feet per minute.

PUMPS.—Rumsey & Co., Seneca Falls, N. Y., have issued the 53rd edition of their illustrated catalogue of hand and power pumps, in a handsome cloth-bound volume of 256 pages. More than 300 illustrations are included, showing pumps for every purpose and in size, from a small hand pump to waterworks steam pumps. The latter part of the catalogue is devoted to special hydraulic appliances and to hydraulic fittings.

"THE LITTLE STORY OF A BIG ORDER."—With this title the Crouse-Hinds Electric Company, Syracuse, N. Y., issues a unique pamphlet consisting entirely of reproductions in full size of telegrams. The initial telegram asks for references previous to awarding to the Crouse-Hinds Company a contract, and the following telegrams are from large firms for which that company has done work, and recommending it in high terms.

ELECTRIC HEADLIGHTS.—The Crouse-Hinds Electric Company, Syracuse, N. Y., in a pamphlet just issued, illustrate and describe various types of changeable electric headlights of its manufacture. A frontispiece illustrates the several steps in car lighting, commencing with the tin lantern of the old stage coach, and having the very pertinent caption: "You are using electricity to light your cars. Why not in your headlight?"

WHITE STAR OIL FILTER.—The unusual demand for the White Star oil filter has forced the Pittsburgh Gage and Supply Company, Pittsburgh, to again enlarge this department of its business by taking th eentire third floor of its new works, 3101-3111 Liberty street, for its exclusive manufacture. The greater part of the second floor will be devoted to holding a large stock of all sizes of the White Star oil filters, this enabling prompt shipments to be made.

ALBERGER COOLING TOWERS.—The Alberger Condenser Company, 95 Liberty street, New York, has issued a well-written and illustrated catalogue on the Alberger system of cooling towers. The illustrations show in detail all the features of the system and include several cuts showing plants as completed. The description very clearly explains the principles of the system and their applicatioon. Those interested in the subject will find much instructive information in this pamphlet.

THE KEYSTONE TELEPHONE COMPANY (independent), of Philadelphia, has issued a handsome folding circular advancing arguments in favor of its system and of the independent telephone movement in general. Much of the information is given in condensed form as answers to questions. For example, the answer to the question: "Don't the Bell own all the principal patents on telephony?" is: "The Independent Telephone companies own and control more patents on telephone systems and apparatus than the Bell; the Independent patents cover superior systems."

BUCKEYE LAMPS.—In a folder entitled, "To Our Friends, the Critical and Careful Public," the Buckeye Electric Company, of Cleveland, Ohio, sets forth its qualifications as a manufacturer of lamps and gives the specific guarantee which its makes to purchasers. Among these guarantees are, that the candle-power will be within the limits of 15-17 cp; that the candle-power will be maintained to 80 per cent. at the expiration of the guaranteed life, and that a life of 600 hours is guaranteed for 3.1-watt lamps, 800 hours for 3.5-watt lamps and 1,000 hours for 4-watt lamps, under a voltage fluctuation of 2 per cent.

BELT CONVEYERS.—The Jeffrey Manufacturing Company, Columbus, Ohio, in Catalogue Noo. 67, illustrates and describes its "Century" system of rubber belt conveyors. A large number of illustrations show different applications of this type of conveyor and details of the rollers, trippers, etc., employed in connection therewith. The catalogue also illustrates the same company's systems of bucket elevators, wood and metal apron conveyors and endless pan conveyors. Several pages are also devoted to Jeffrey crushers, screens and electric elevators. Those interested in elevators and conveyors will find this pamphlet an instructive contribution to these subjects.

KEYSTONE HAIR INSULATOR.—In a leaflet just issued by the H. W. Johns-Manville Company., New York, are shown the results of recent tests of Keystone hair insulator and other heat-insulating materials. The hair insulator, according to the report, shows a gain of 25 per cent. over hair felt and cork construction; 33 per cent. over 1-in. air space construction, and 42 per cent. over solid construction. This report is condensed from a paper read by Mr. John E. Starr before the convention of American Warehousemen, held at Buffalo, last October. The company has also issued a pamphlet describing and illustrating the varied uses of its Keystone hair insulator, which will be of interest to those concerned in insulation of heat, cold and sound.

AMERICAN SCHOOL OF CORRESPONDENCE.—An arrangement has been made with the Armour Institute of Technology, Chicago, whereby this institute will co-operate with the American School of Correspondence in providing technical education by correspondence. Dr. Frank W. Gonsaulus, president of the Armour Institute of Technology, is the head of the Advisory Board of the American School, and the faculty of the Armour Institute is associated with the faculty of the school in the instruction of students of the latter. All examination papers from students in the vicinity of Chicago will go directly to the faculty of the Armour Institute for correction and criticism, and the American School students will receive full credit toward a degree in the Armour Institute for work done in the American School.

THE ELECTRONIC THEORY.—In *The Popular Science Monthly* for July of last year Prof. J. J. Thomson described his important investigations demonstrating that atoms can be split up into smaller bodies. In the current issue of the same magazine, Prof. J. A. Fleming, the eminent British physicist, explains in clear and readable language the electronic theory of electricity, to which Professor Thomson's researches were such an important contribution. All ideas regarding electricity, matter and ether, as held even by those who have followed the progress of physical science, must, it appears, be revised. It is necessary to regard electricity as atomic in structure, the atoms of electricity being attached to the atoms of matter and separable from them. The regular free movements of electrons create what we call the electric current in a conductor, whereas their vibrations when attached to atoms are the cause of ether waves whether of light or heat. The atom is a kind of planet accompanied by other smaller satellites which are capable of an independent existence and are then the so-called negative electricity. The inertia of matter is due to the electron, and all mechanical and material effects must be translated into the language of electricity.

BEFORE THE TROLLEY.—In those days—back in the Mexican War period—Michigan was a wilderness, the railroads were built with strap rails, and time cards and the telegraph were unknown. One man, with a foot-power lathe, did all the repairing for the entire system (Michigan Central Railroad); every coach bore a name, generally immortalizing some town along the road. The engineer was also the conductor and the fireman officiated as brakeman. To put on brakes a long lever was let down on the tender and the brakeman stood upon it, that being the only brake used in those primitive days. Night trains were not thought of until some time after; the first "owl trains" carrying a headlight which burned lard oil that, in cold weather, had a habit of freezing up, when the light would flicker out, leaving the train wrapped in Michigan darkness. Trains were as apt to be ten or fifteen minutes ahead of time as thirty or forty minutes behind time, and passengers never calculated on getting to the depot on the minute, as in these days. Night freights used no headlights, and there were no brakemen on any freight trains, for there were no brakes. A conductor and a greaser constituted the crew.—From "Along the Railroads," in *Four-Track News* for April.

Record of Electrical Patents

UNITED STATES PATENTS ISSUED APRIL 29, 1902.

[Conducted by Wm. A. Rosenbaum, Patent Attorney, 140 Nassau st., N. Y.]

698,532. TROLLEY CONTROLLER; P. D. Milloy, Buffalo, N. Y. App. filed March 28, 1901. The trolley rope leads around a pulley to a spring drum. The pulley is carried at the end of a spiral spring normally under tension. When the trolley leaves the wire, its upward movement trips the spring which draws the pulley and the rope downward. The spring drum takes up the slack.

698,575. ELECTRIC ARC LAMP; P. H. F. Spies, Mount Vernon, N. Y. App. filed June 5, 1901. Details of the general construction.

698,612. TELEPHONIC WALL SET; C. E. Wilson, Philadelphia, Pa. App. filed July 26, 1901. (See Page 820.)

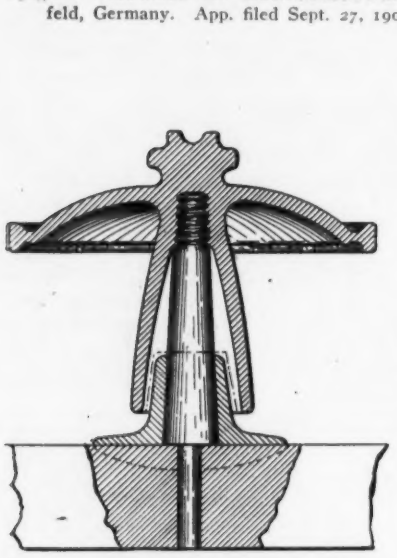
698,613. BASE-PLATE FOR TELEPHONE TRANSMITTER-ARMS; C. E. Wilson, Philadelphia, Pa. App. filed July 26, 1901. (See Page 820.)

698,637 to 698,693. The fifty-seven patents comprised have for subjects Electric Meters, Electrical Measuring Instruments, Direct-Current Meters, Alternating-Current Meters, Alternating-Current Motor Meters, Induction Motor Meters, Polyphase Motor Meters and Motor Meters. The patentee is Thomas Duncan, of Fort Wayne, Ind., and Chicago, Ill. The dates of filing of applications are from Feb. 7, 1898, to March 10, 1900.

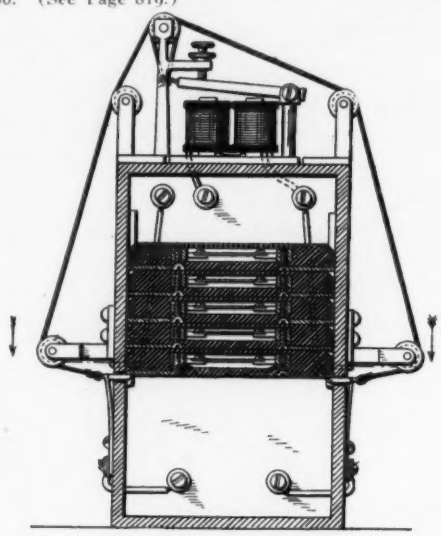
698,696. PROCESS OF MAKING PARIS GREEN; R. Franchot, Niagara Falls, N. Y. App. filed Aug. 17, 1901. (See Page 819.)

698,738. ELEVATOR; A. B. Roney, Chicago, Ill. App. filed Oct. 10, 1901. A rotating drum attached to the elevator car and having a large worm on its exterior engaging with a rack on the side of the shaft, is rotated by an electric motor inside of the drum to raise and lower the car.

698,766. PROCESS OF MANUFACTURING GLASS; A. Voelker, Ehrenfeld, Germany. App. filed Sept. 27, 1900. (See Page 819.)



698,976. Sleeve for Protecting Insulator Pins.



699,045. Safety Fire Box.

698,792. ARC LIGHT HANGER-BOARD; H. M. Buck and W. H. Strippy, Baltimore, Md. App. filed June 15, 1901. The lamp is suspended from two pivoted levers which are at the same time the movable elements of an electric switch. When the lamp is removed, the levers automatically bridge the terminals on the board.

698,811. LOCK; H. G. Carleton, New York, N. Y. App. filed March 18, 1901. Details of construction of an electric lock designed to prevent tampering with the circuit.

698,812. LOCK; H. G. Carleton, New York, N. Y. App. filed April 17, 1901. A device constituting the locking number consisting of a three-armed lever, supported upon a knife-edge bearing; one arm is an armature and the other arms are operated by the key and knob apparatus.

698,813. ELECTRIC ALARM AND FASTENING DEVICE; H. G. Carleton, New York, N. Y. App. filed April 23, 1901. A burglar alarm circuit closer, serving at the same time as a lock for a sash.

698,827. CONTROLLER FOR ELEVATORS; F. K. Fassett, St. Louis, Mo. App. filed Sept. 9, 1901. A modification of that form of control wherein the car cannot be started until the door at the landing is closed, in which certain limiting devices are introduced, permitting the car to be started before the door is closed, but stopping and returning the car automatically in case the door has not been eventually closed.

698,902. CONDUIT; C. D. Budd, St. Louis, Mo. App. filed Dec. 9, 1901. Cement blocks having corresponding grooves to form passages when placed together, and tongues and grooves to prevent displacement.

698,931. ELECTRIC ARC LAMP; C. Gilbert, Bridgeport, Ohio. App. filed Jan. 12, 1900. Details.

698,942. SIGNAL STATION; J. W. Harrison, Detroit, Mich. App. filed March 13, 1901. A signal for trolley stations, in which the presence of a would-be passenger in the station will, by his weight on the tilting floor, set a signal to stop the car.

698,965. CONNECTION OF STRIKERS TO MOTOR VEHICLES FOR MECHANICALLY-OPERATING ELECTRIC SWITCHES; W. Kingsland, London, Eng. App. filed Aug. 28, 1901. The striker is mounted at the free end of a horizontal arm, the opposite end of the latter being carried upon a vertical pivot-pin, which is supported from the axle box.

698,976. SLEEVE FOR PROTECTING INSULATOR PINS; F. M. Locke, Victor, N. Y. App. filed Nov. 11, 1901. A sleeve for an insulator-pin, constructed of porcelain or similar material, having a flange at the bottom extending out to a point beyond the point at which the base of the insulator would intersect the cross-arm in case the insulator-base was extended.

698,978. TROLLEY WHEEL; G. Loffi, Norwalk, Ohio. App. filed Sept. 7, 1901. The flanges and treads are assembled upon a bushing and confined between two nuts threaded on the ends of the bushing.

698,979. TROLLEY ARM HEAD; F. J. Ludolph, Irondequoit, N. Y. App. filed Aug. 31, 1901. Guards are formed on the head to retain the wheel on the wire.

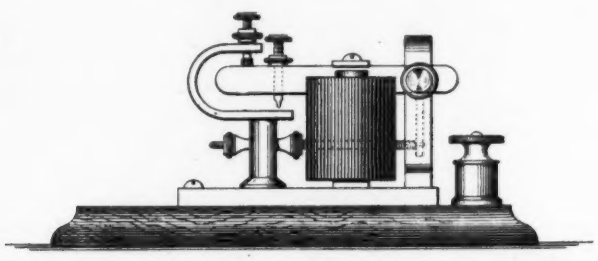
698,981. ELECTRIC FURNACE FOR MAKING GLASS, ETC.; J. Luhne, Aachen, Germany. App. filed Dec. 26, 1899. (See Page 819.)

698,985. ELECTRIC CLOCK; E. Meyer, Jersey City, N. Y. App. filed July 19, 1901. Details.

699,012. PROCESS OF OBTAINING TIN BY ELECTROLYSIS; E. Quintaine, Argenteuil, France. App. filed April 24, 1900. (See Page 819.)

699,025. AUTOMATIC DEVICE FOR THE SAFE OPERATION OF ELECTRIC CONDUCTORS WITH OR WITHOUT GUARD WIRES; E. E. Shultz and C. S. Y. Orfila, Barcelona, Spain. App. filed Aug. 21, 1900. An automatic cut-out, effective in case the trolley or other conductor breaks.

699,029. CONTROLLER FOR ELECTRIC VEHICLES; A. L. Simpson and H. B. Palmer, New York. App. filed Dec. 13, 1901. Means for forming a short circuit around the contacts of rheostat at the instant when the arm is moving from one to another.



699,056. Telegraph Sounder.

699,045. SAFETY FUSE BOX; J. T. Watson, Scranton, Pa. App. filed July 8, 1901. A number of fuse-blocks are supported one above the other and sustained by latches, the lower fuse being the one in circuit. When the lower fuse is destroyed, an electro-magnet withdraws the latches, allowing the lower block to drop out of position and the next one to come into the circuit.

699,055. ALTERNATING CURRENT REGULATOR; T. E. Adams, Cleveland, Ohio. App. filed Dec. 2, 1901. The regulator is constructed in such manner that the use of counter-balancing weights or springs independent of the weight of the coils and core and the frames which carry them, will be avoided; this being accomplished by balancing one part against another.

699,056. TELEGRAPH SOUNDER; J. A. Albertson, Lansford, Pa. App. filed June 20, 1901. The back-stop is provided with a cushion, so that it will give out a different sound from the front stop, when struck by the armature.

699,060. RAIL BOND; F. B. Badt and G. M. Willis, Chicago, Ill. App. filed Dec. 2, 1901. The end-pieces adapted to enter holes in the rail, have conical plugs inserted in each end, which are adapted to be driven inward to spread the end.

699,064. RHEOSTAT, ELECTRIC HEATER, ETC.; H. P. Ball, Mount Vernon, N. Y. App. filed June 27, 1898. A unit element consisting of a plug of porcelain, having a resistance wire wound or embodied in it, the device being adapted for insertion into the frame of an electric heater.

699,119. AUTOMATIC SIGNAL FOR ELECTRIC RAILWAYS; C. H. Storm, Waterloo, Iowa. App. filed Jan. 19, 1901. The trolley wheel operates an overhead switch at the ends of the blocks to change the color of the signal lights.